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| <b>14. ABSTRACT</b><br><br>To identify metastatic suppressor genes (MSGs), I proposed to perform genome-scale genetic perturbation using lentiviral delivered shRNA library in a mouse model of breast cancer metastasis and an in vitro metastasis assay. To enhance the screening throughput and robustness of the mouse metastasis model, I calibrated an ALSV-based lentiviral gene delivery system. This system achieved reasonable virus delivery efficiency in vitro and to subcutaneously formed tumor in vivo. However, it failed to delivery genes to primary breast tumor in vivo. In parallel, I generated list of candidate MSGs and tested the shRNAs for selected candidate for pilot screen in vivo. The MSGs includes known/putative MSGs through literature research and genes that is essential specific to metastatic breast cancer cell lines. Further experiment is on going to use the candidate list to calibrate the in vivo and in vitro metastasis assay systems. |                         |   |   |   |   |
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## Introduction

Metastases are major cause of cancer death. Although recent advances have revealed gene signatures that predict the risk of metastasis, we still lack insight into the molecular mechanism(s) that underlie this process. In this breast cancer research training program, I proposed to identify metastasis suppressor genes (MSGs) by systematically manipulating gene expression using genome-scale pooled shRNA library in experimental breast cancer metastasis models. I expect to identify a number of candidate MSGs using this approach. To prioritize genes for further study, candidate genes will then be compared with data derived from genomic analysis on human metastasis breast cancer to identify MSGs. Putative MSGs will be further characterized for their role in breast cancer metastasis.

## Body

Metastasis is a complex process involving in genetic alterations of tumor cells and homeostatic changes in the host. Mouse model of breast cancer metastasis best recapitulates the entire pathological process among numerous assays modeling metastasis. To identify potential MSGs, I proposed to introduce pools of The RNAi consortium (TRC) library into non-metastatic breast cancer cell lines, then implant the cells to mammary fat pad to form primary tumor and select shRNAs that promote metastasis (Aim 2 in proposal). One technical challenge of using this system to perform a genome-wide perturbation is that only a fraction of cells are able to form primary tumor at mammary fat pad and therefore losing the complexity of the shRNA library. My current work tackles this problem from two aspects:

- (I) To introduce virus library directly to primary tumor
- (II) To reduce the complexity of shRNA library by generating a high priority list of genes for *in vivo* MSGs screening

### (I) To introduce virus library directly to primary tumor

Current strategy to use shRNA library for *in vivo* MSGs discovery involves first introducing shRNA library to tumor-derived cell lines, then transplanting these engineered cell lines into immunocompromised mice via orthotopic xenograft or intravenous injection and last deconvoluting shRNA library from metastatic tumor. There are couple disadvantages associated with this strategy: (1) The shRNA library is introduced to tumor-derived cell lines rather than tumor cells of origin. (2) The engineered cell line is introduced to immunocompromised mice and therefore the result cannot account the effect of host immune system towards tumor formation and metastasis. (3) When introducing engineered cell line to the host through orthotopic xenograft, only a fraction of cells can initiate tumor after transplant *in vivo*, therefore compromising the capacity of this system to screen a large panel of candidate shRNAs. (4) When introducing engineered cell line to the host through intravenous injection, the system only examines the later portion of metastasis rather than the full spectrum of this process. To study metastasis with mammary origin in non-immunocompromised mice *in vivo*, I took advantage of an established virus infection system to allow delivery of shRNA library to tumor *in vivo*.

This virus infection system takes advantage of avian sarcoma-leukosis virus (ASLV) which specifically infects cells expressing TVA receptor. In last report, I demonstrated the lentiviral vector, pseudotyped with the envelope protein of ALSV subgroup A (EnvA), is able to deliver and express target gene specifically in cell lines expressing TVA receptor *in vitro*. Furthermore, I demonstrated the infection efficiency of EnvA lentivirus in subcutaneously formed tumor when the virus is delivered by tail vein injection.

To test whether this system allow me to deliver virus to mammary tumor *in vivo*, I first conducted experiment to see whether ASLV based virus delivery can introduce oncogene to mammary epithelial cells expressing TVA receptor and promote primary mammary tumor formation. I obtained transgenic mice with TVA receptor under the control of mouse mammary tumor virus (MMTV) promoter from Dr. Yi Li (Baylor College of Medicine). It has been demonstrated that somatic delivery of either mouse polyoma virus middle T antigen (PyMT) or neu oncogene using ALSV-based retroviral vector to MMTV-TVA mice induced the formation of multiple, oligoclonal tumors within 3 weeks in infected mammary glands [Du Z, et al. 2006]. To further promote tumor formation in this mouse model, I generated MMTV-TVA/p53(-/-) mice by crossing MMTV-TVA mice with p53 null mice. The rationale is basing on previous publications showing strong cooperative effect between HRas or neu with p53 mutation in forming mammary tumor [Hundley, J.E., et al., 1997; Li, B., et al., 1997]. To induce primary tumor formation, EnvA lentivirus encoding HRas or neu protein was delivered to 8-weeks old female MMTV-TVA and MMTV-TVA/p53(-/-) mice through tail vein injection. Five mice from each genetic background were injected for each oncogene. Three injections were done for each mouse in three consecutive weeks. Mouse mammary tissue had been monitored for 5 months by palpation. No breast tumor was identified under any of the experimental conditions. One possible explanation is that the efficiency of virus delivery to mammary epithelial tissue is poor.

In parallel, I am initiating part of the *in vivo* screening experiment described in Aim1 and 2 in the proposal. Current working in progress includes:

- (1) I obtained the dual-color cell cycle reporter from Dr. Atsushi Miyawaki (RIKEN, Japan) and I am current testing the validity of this reporter.
- (2) I plan to introduce this dual-color reporter to both metastatic and non-metastatic breast cancer cell lines and assay whether this reporter can distinguish proliferating vs. dormant colonies *in vivo*.

(II) To reduce the complexity of shRNA library by generating a high priority list of genes for *in vivo* MSGs screening

In order to perform *in vivo* MSGs screen successfully, I decided first to perform pilot screen using a shRNA library consisting of genes with high potential to be MSGs. My rationales are as following:

- (1) Recently, Possemato et al. successfully performed negative selection genetic screen looking for breast cancer target using mouse model of breast cancer [Possemato, R., et al., 2011]. The authors first introduce shRNA library to breast cancer cell lines *in vitro*, which were subsequently injected to mammary fat pad to assay tumor maintenance phenotype. In this study, a shRNA library targeting 133 metabolic enzyme and transporter genes was used. Adaptation of a smaller library enriched of biological candidate allows the screen to be conducted under stringent condition.
- (2) As proposed in Aim3, I will prioritize candidate MSGs obtained from *in vivo* screen by intersecting the candidate list with list of genes with heterozygosity (LOH) in human cancer cell lines and breast cancer specimens accessed by high-density short nucleotide polymorphism (SNP) arrays. Therefore, it is reasonable to focus on genes which have genetic alterations in metastatic breast cancer first in a pilot screen.

In the *in vivo* experiment described in Aim 1 of the proposal, the system will allow me to study the dynamic metastatic tumor population in live animals by following both proliferating and dormant metastatic lesion. In order to generate a prioritized candidate gene list, I conducted the following research. Part (1) focuses on candidate MSGs that promote metastasis in general which may function through one or multiple steps during metastasis formation. Part (2) aim to tackle specific set of genes that promote growth of dormant cells.

- (1) To generate a list of putative MSGs basing on literature and tested shRNAs against selected genes

Prior studies have identified several putative MSGs, including ARHGDIB, CDH1, KAI1, CRSP3(MED23), DAB2IP, DNAJB4, EZH2, GAS1, HOXD10, PEBP1, PRDM13 and SETD2. I tested knockdown efficiency of shRNAs against selected putative MSGs in MCF7 breast cancer cell line. Specifically, MCF7 cells were infected with VSV-G pseudotyped lentivirus expressing shRNA against selected putative MSGs. RNA was collected at three and five days after virus infection and the depletion of target was detected by qRT-PCR. The result from day five is shown in Figure 1. For each candidate gene, I have two to three shRNAs which reduce target transcript level more than 50% at day 5 post virus infection. Knocking down these putative MSGs does not affect viability of MCF7 cells at time points tested. I plan to test whether perturbation of these genes in MCF7 cells could enhance its migration and invasion ability in Matrigel transwell assay (BD Biosciences) (described in aim2 of the proposal).

- (2) To generate list of genes that is essential in metastatic breast cancer

Metastatic cancer cells may persist as small asymptomatic microscopic colonies for prolonged periods of time before the eventual outgrowth. These dormant tumor cells are believed to be at least in part responsible for cancer recurrence that can occur decades after apparently successful initial treatment. The survival of

dormant lesions, their eventual activation and outgrowth require additional tumor-intrinsic or tumor-extrinsic factors. Mechanistically, highly metastatic tumor cells may dependent on specific set of genes/factors for enhanced growth comparing to primary tumor. Conversely, losing these genes/factors may compromise the growth of metastatic tumor cells specifically. I reason to characterize such set of genes which are essential only in metastatic cells could help us to explain how dormant cells develop into proliferative metastatic lesions.

In order to generate a list of genes specifically essential in metastatic breast cancer, I took advantage of meta-dataset systematically documenting gene essentiality in 201 human cancer cell lines. To have a comprehensive understanding of the molecular vulnerabilities of every type of cancer, the RNAi Consortium at Broad Institute begun an effort to systematically access the essentiality of 11,194 genes in 201 human cancer cell lines by performing genome-scale loss-of-function study. The data from 102 human cancer cell lines is currently publically available.

Briefly, genome-scale, pooled shRNA screens were performed in 201 cancer cell lines, including 13 breast cancer cell lines to identify genes essential for proliferation and survival. Each cell line was infected in quadruplicate with a lentivirally delivered shRNA pool, comprising 54,020 shRNAs targeting 11,194 genes, and propagated for at least 16 population doublings. The abundance of shRNA constructs at the endpoint relative to the initial reference pool was measured by microarray hybridization using a customized array or Illumina sequencing. Genes whose abundances are relatively depleted through the course of experiment are essential to the cancer cell lines.

By integrating these functional data with genetic analysis of primary human tumors and cancer cell lines, they identified known and putative oncogenes, genes involved in response to tumoricidal agents, novel lineage-specific essential genes and genes synthetic lethal to oncogenic KRas mutation[Luo,B., et al., 2008; Cheung,H.W., et al., 2011; Barbie,D.A., et al., 2009].

To identify genes whose essentiality could be associated specifically with metastatic breast cancer, I compared the essentiality of same genes between metastatic vs. non-metastatic breast cancer cell lines and determine a list of genes who are significantly more essential in metastatic breast cancer cell lines. The specific steps I performed are described below:

#### (2.1) To classify the breast cancer cell lines basing on its metastatic status

To classify breast cancer cell lines basing on its metastatic status, multiple orthogonal approaches can be applied, for example, basing on pathology annotation of cell line source of origin, functionality of cell lines in *in vitro* and *in vivo* metastasis assay and gene expression signature that is associated with metastasis. I adopt a previously established cell line classification using a 70-gene prognostic signature supervised on the metastatic/non-metastatic distinction of 117 primary breast tumors[van,t,V., et al., 2002; Kao,J., et al.,

2009]. Patients whose tumor contain 70-gene signature have poor prognosis and prone to have metastasis[van,'t,V., et al., 2002]. Among 13 breast cancer cell lines, six cell lines are identified to contain the 70-gene signature while another six cell lines are lack of association with this signature (Table 1). The six cell lines with 70-gene signature may be considered to reflect the status of metastatic breast tumor. Given the significant genetic heterogeneity of cancer cell lines, multiple cells lines were used to represent each class of cells in the following comparison.

(2.2) To identify genes are essential specifically in metastatic breast cancer cell lines

To identify genes that are selected to be essential in metastatic breast cancer cell lines, I did the following:

(2.2.1) To analyze the dataset, we converted the results of massively parallel screening of 54,020 individual shRNAs targeting 11,194 genes to quantitative, gene-level scores using the ATARiS algorithm (A.T., D.S, W.C.H and J.M personal communication), which identifies sets of shRNAs with similar behavior across all samples. Thus the gene score derived from ATARiS allows me to compare the gene essentiality quantitatively across the cell lines.

(2.2.2) I used a two-class comparison analysis to detect genes that were significantly more essential for the survival/proliferation of cell lines with 70-gene signature. Two methods were used to perform two-class comparison analysis.

One is basing on weight of evidence (WoE), which computes the likelihood that a given shRNA has the ability to discriminate between the two classes of interest in a statistically significant manner[Cheung,H.W., et al., 2011]. Using a p-value cut off of 0.05, four hundred and forty-five genes were selected (Table 2).

Another one is to identify genes that are correlated with metastatic breast cancer cell lines by their signal-to-noise statistic:  $(\text{MEDIAN}_{\text{class(A)}} - \text{MEDIAN}_{\text{class(B)}}) / (\text{STD}_{\text{class(A)}} + \text{STD}_{\text{class(B)}})$ , where MEDIAN and STD are the median and standard deviation of the ATARiS value[Luo,B., et al., 2008]. Top 731 genes were selected basing on a signal-to-noise cut off value of -0.5 (Table 3).

A high confidence of list of genes was generated by taking the overlap of the two previous lists (Table 4). I further evaluated biological pathways represented among this candidate list of genes. Go term analysis using GSEA shows enrichment of MAPK activating genes (Table 5). Box plot of ATARiS score of selected MAPK activating genes that are enriched in metastatic cell lines shows the dynamic range of their differential essentiality between two classes of cell lines (Figure 2).



Future plan includes annotate this candidate list further with copy number and gene expression data in the 12 breast cancer cell lines to select list of genes that are both essential and have higher gene expression level or amplification in metastatic breast cancer cell lines. The candidate genes will be tested *in vivo* for their function of supporting metastatic tumor growth.

### **Breast Cancer Research Training Program**

The funding of DoD Breast Cancer Postdoctoral Fellowship has given me tremendous support in the past two years. Couple progresses of me as a breast cancer researcher are listed as below:

- (1) The financial support of DoD fellowship allows me to continue conduct scientific research of my interest and with a goal of benefiting the public.
- (2) I attended the Era of Hope conference last year under the support of DoD fellowship. This conference was a great opportunity for me to get in touch with people conducting high quality of research. It was a fertile experience for me of learning and networking.
- (3) As a scientist trained by the bench side transitionally, I am benefited from working on this proposal through developing my computational biology skills under the guidance of my mentor Dr. William Hahn and Dr. Shirley Liu (Dana Faber Cancer Institute). As more and more large scale functional and genomic dataset becomes available, the skills I am currently developing will not only serve me as a tool to solve my questions but also as a way to generate new hypothesis for me to test. It helps tremendously to build up my foundation as a breast cancer researcher in the future.

### **Key Research Accomplishments**

- Evaluated ASLV-based virus delivery to mouse primary mammary gland tumor
- Generated a list of candidate MSGs genes for pilot screen and tested shRNAs for selected candidate genes

### **Reportable Outcomes**

Not Available

### **Conclusion**

The goal of my research is to identify MSGs in a murine model of metastatic breast cancer. In order to setup a robust system allowing me to perform large-scale gene perturbation *in vivo*, I initiated an ALSV-based lentiviral gene delivery system aiming to deliver virus directly to primary mammary gland tumor in mice. My previous work demonstrated that this gene delivery system efficiently permits gene expression both in

cultured cell lines *in vitro* and in subcutaneous tumor *in vivo*. To test whether this system allows gene delivery to orthotopic tumor, I introduced lentivirus carrying oncogene to mice expressing the virus receptor in mammary gland. However, I failed to observe any mammary gland tumor formation. In the next phase to discover MSGs *in vivo*, I plan to introduce the shRNA library to cell lines *in vitro* then introduce the engineered cell lines *in vivo*. In parallel, I compiled a list of candidate MSGs for pilot screen. These candidate MSGs includes known putative MSGs and genes that are essential for metastatic breast tumor. The candidate genes will be tested both *in vitro* and *in vivo* for their function in migration, invasion and metastasis formation.

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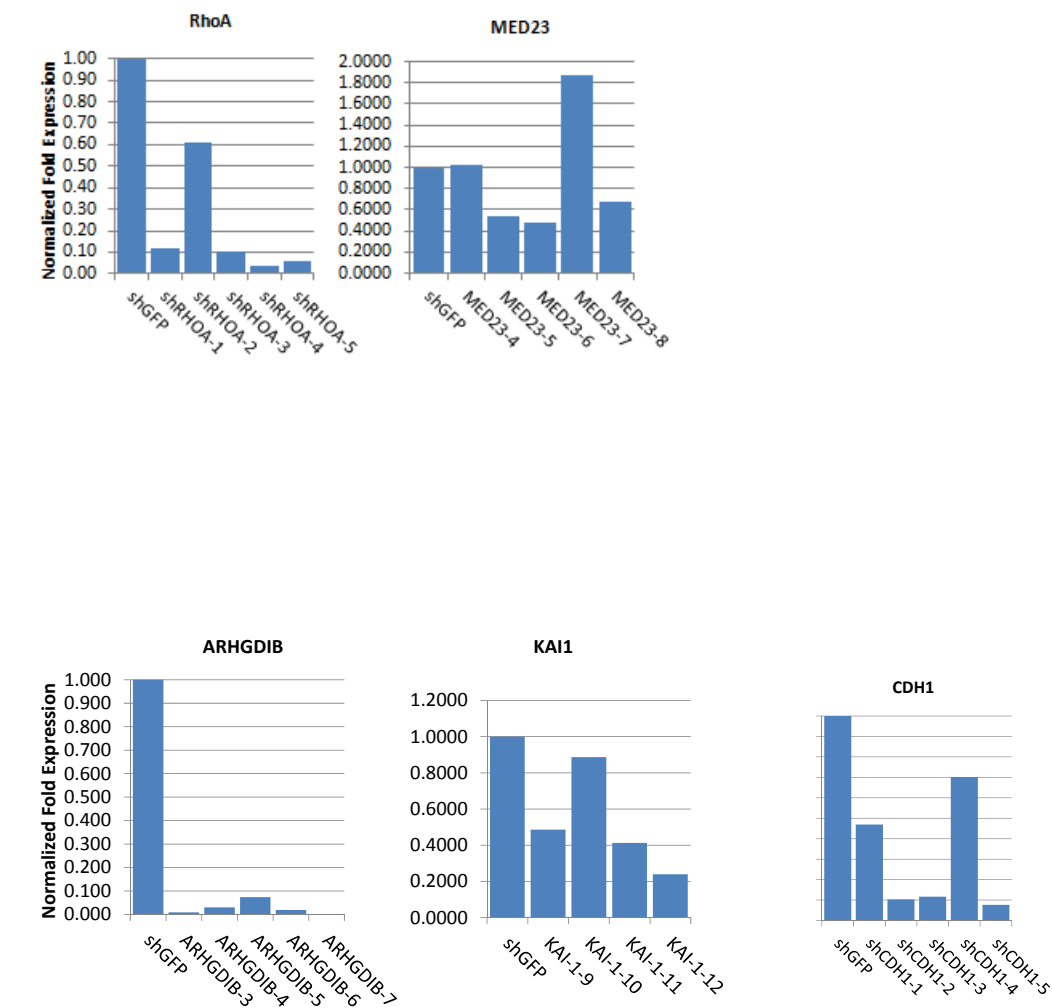
van, '., V, Dai,H., van,d., V, He,Y.D., Hart,A.A., Mao,M., Peterse,H.L., van der,K.K., Marton,M.J., Witteveen,A.T., Schreiber,G.J., Kerkhoven,R.M., Roberts,C., Linsley,P.S., Bernards,R., and Friend,S.H. (2002). Gene expression profiling predicts clinical outcome of breast cancer. *Nature* *415*, 530-536.

## **Appendices**

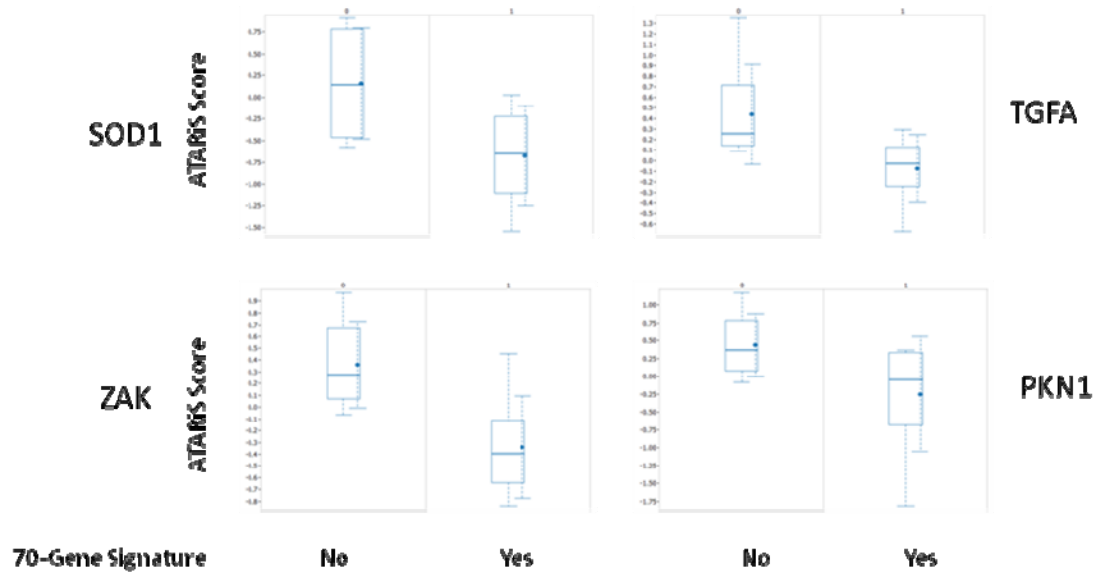
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## Supporting Data

**Figure 1: Testing shRNA Knockdown Efficiency of Putative MSGs**

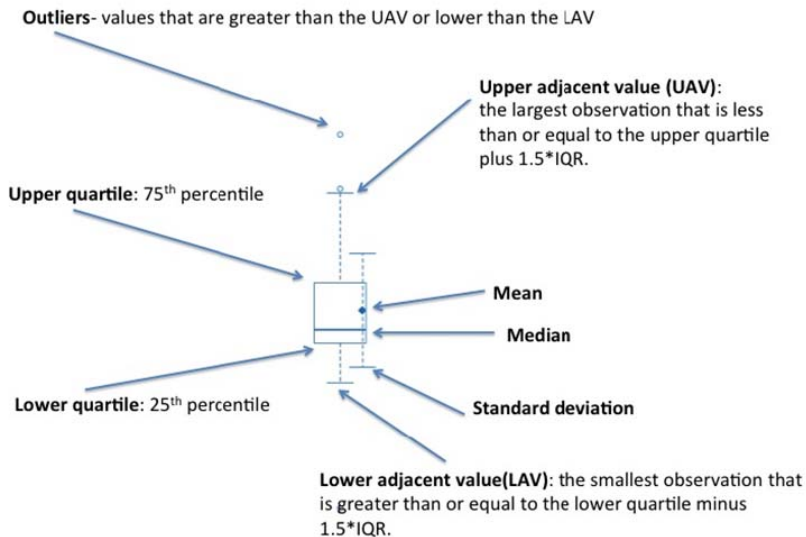


**Figure 2: Box Plot of ATARIS Score of Selected Metastatic Essential Genes in Cell Lines with or without 70-Gene Signature**



**Note: the more negative ATARIS score means the gene is more essential in that cell line**

**Figure 2 Legend**



<http://www.broadinstitute.org/cancer/software/GENE-E/>

**Table 1: Classification of Breast Cancer Cell Lines into Molecular Subtypes**

| Cell Line | 70 Gene | HER2     | Subtype          | Pathology  | KRAS | PIK3CA                      | BRAF       | NRAS | PTEN          | APC | CDKN2A | CTNNB1 | TP53       | STK11 | EGFR |
|-----------|---------|----------|------------------|------------|------|-----------------------------|------------|------|---------------|-----|--------|--------|------------|-------|------|
| BT20      | Yes     | Negative | ductal Carcinoma | NA         | WT   | PIK3CA_H1047R, PIK3CA_P539R | WT         | WT   | WT            | WT  | WT     | WT     | TP53_K132Q | WT    | WT   |
| BT474     | No      | Positive | ductal Carcinoma | NA         | WT   | PIK3CA_K111N                | BRAF_V600E | WT   | WT            | WT  | WT     | WT     | TP53_E285K | WT    | WT   |
| CAL120    | NA      | NA       | NA               | NA         | WT   | WT                          | WT         | WT   | WT            | WT  | WT     | WT     | TP53_?     | WT    | WT   |
| CAL51     | No      | Negative | NA               | NA         | WT   | PIK3CA_E542K                | WT         | WT   | WT            | WT  | WT     | WT     | NA         | WT    | WT   |
| EFM19     | Yes     | Negative | ductal Carcinoma | metastasis | WT   | PIK3CA_H1047L               | WT         | WT   | WT            | WT  | WT     | WT     | TP53_H193R | WT    | WT   |
| HCC1187   | Yes     | Negative | ductal Carcinoma | NA         | WT   | WT                          | WT         | WT   | WT            | WT  | WT     | WT     | WT         | WT    | WT   |
| HCC1395   | Yes     | Negative | ductal Carcinoma | NA         | WT   | WT                          | WT         | WT   | PTEN_N212fs*1 | WT  | WT     | WT     | TP53_R175H | WT    | WT   |
| HCC1954   | Yes     | Positive | ductal Carcinoma | NA         | WT   | PIK3CA_H1047R               | WT         | WT   | WT            | WT  | WT     | WT     | TP53_Y163C | WT    | WT   |
| HCC2218   | No      | Positive | ductal Carcinoma | NA         | WT   | WT                          | WT         | WT   | WT            | WT  | WT     | WT     | TP53_R283C | WT    | WT   |
| HCC70     | Yes     | Negative | ductal Carcinoma | primary    | WT   | WT                          | WT         | WT   | PTEN_F90fs*9  | WT  | WT     | WT     | TP53_R248Q | WT    | WT   |
| MCF7      | No      | Negative | Carcinoma        | NA         | WT   | PIK3CA_E545K                | WT         | WT   | WT            | WT  | WT     | WT     | WT         | WT    | WT   |
| MDAMB453  | No      | NA       | Adenocarcinoma   | metastasis | WT   | PIK3CA_H1047R               | WT         | WT   | WT            | WT  | WT     | WT     | WT         | WT    | WT   |
| ZR7530    | No      | Positive | ductal Carcinoma | NA         | WT   | WT                          | WT         | WT   | WT            | WT  | WT     | WT     | WT         | WT    | WT   |

**Table 2: List of Candidate Metastatic Essential Gene by WoE**

| Rank | Gene         | Score | Metric: WE | Nominal p-val |
|------|--------------|-------|------------|---------------|
| 1    | LOC100508181 | -170  | -170       | 0.000111      |
| 2    | OSTM1        | -162  | -162       | 0.000221      |
| 3    | LOC649330    | -140  | -140       | 0.000332      |
| 4    | SSX1         | -126  | -126       | 0.000442      |
| 5    | INHBA        | -107  | -107       | 0.000553      |
| 7    | LOC100287382 | -104  | -104       | 0.000774      |
| 6    | LOC729468    | -104  | -104       | 0.000774      |
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| 9    | IARS2        | -66.9 | -66.9      | 0.000995      |
| 10   | FAM108B1     | -55.5 | -55.5      | 0.00111       |
| 11   | SLC4A1       | -54.9 | -54.9      | 0.00122       |
| 12   | ZBTB32       | -53.5 | -53.5      | 0.00133       |
| 13   | PRMT1        | -48.8 | -48.8      | 0.00144       |
| 14   | LUC7L2       | -45.9 | -45.9      | 0.00155       |
| 15   | SPOCK1       | -43.3 | -43.3      | 0.00166       |
| 16   | DCTN4        | -28.8 | -28.8      | 0.00177       |
| 17   | PTPRJ        | -21.4 | -21.4      | 0.00188       |
| 18   | WIF1         | -13.2 | -13.2      | 0.00199       |
| 19   | NUP107       | -12.7 | -12.7      | 0.0021        |
| 20   | GZMB         | -10.9 | -10.9      | 0.00221       |
| 21   | PPP1R10      | -8.78 | -8.78      | 0.00232       |
| 22   | NROB2        | -7.13 | -7.13      | 0.00243       |
| 23   | THBS2        | -7.07 | -7.07      | 0.00254       |
| 24   | TMEM33       | -6.76 | -6.76      | 0.00265       |
| 25   | GUCY1B2      | -6.46 | -6.46      | 0.00276       |
| 26   | PRSS55       | -5.93 | -5.93      | 0.00287       |
| 28   | HNRNPA3P1    | -5.75 | -5.75      | 0.00309       |
| 27   | ADPGK        | -5.75 | -7.75      | 0.00309       |
| 29   | TP53BP1      | -5.68 | -5.68      | 0.00321       |
| 30   | HNRNPH1      | -5.38 | -5.38      | 0.00332       |
| 31   | TNFSF10      | -5.33 | -5.33      | 0.00343       |
| 32   | OR2T10       | -5.1  | -5.1       | 0.00354       |
| 33   | KCNK2        | -4.99 | -5.39      | 0.00365       |
| 34   | ALDOA        | -4.66 | -4.66      | 0.00376       |
| 35   | BCL2         | -4.62 | -4.62      | 0.00387       |
| 36   | PHTF2        | -4.57 | -4.57      | 0.00398       |
| 37   | MTHFD1L      | -4.51 | -4.51      | 0.00409       |
| 38   | ZNF628       | -3.94 | -3.94      | 0.0042        |
| 39   | SMAD9        | -3.78 | -3.78      | 0.00431       |
| 40   | FGF9         | -3.77 | -3.77      | 0.00442       |
| 41   | PVRL4        | -3.63 | -3.63      | 0.00453       |
| 42   | CNTNAP1      | -3.58 | -3.58      | 0.00464       |
| 43   | RGS1         | -3.47 | -3.47      | 0.00475       |
| 44   | TNK1         | -3.34 | -3.34      | 0.00486       |



|    |         |       |       |         |
|----|---------|-------|-------|---------|
| 45 | ZFP112  | -3.3  | -3.3  | 0.00497 |
| 47 | RFK     | -3.29 | -3.29 | 0.0052  |
| 46 | ACVR2B  | -3.29 | -3.29 | 0.0052  |
| 48 | S100B   | -3.25 | -3.25 | 0.00531 |
| 49 | ELAC1   | -3.24 | -3.24 | 0.00542 |
| 50 | SPI1    | -3.2  | -3.2  | 0.00553 |
| 52 | CALM3   | -3.16 | -3.2  | 0.00575 |
| 51 | BCAS2   | -3.16 | -3.16 | 0.00575 |
| 53 | KHDRBS2 | -3.13 | -3.8  | 0.00586 |
| 54 | ATP5G3  | -3.06 | -3.06 | 0.00597 |
| 55 | GRIK4   | -3.03 | -3.03 | 0.00608 |
| 56 | TGFA    | -3.02 | -3.02 | 0.00619 |
| 57 | ZNF347  | -3.01 | -3.06 | 0.0063  |
| 58 | HNRNPA3 | -2.97 | -2.97 | 0.00641 |
| 59 | CHN2    | -2.95 | -2.95 | 0.00652 |
| 60 | ATP6AP2 | -2.86 | -2.86 | 0.00663 |
| 62 | CD55    | -2.81 | -3.45 | 0.00685 |
| 61 | C5orf32 | -2.81 | -2.81 | 0.00685 |
| 63 | IRS2    | -2.8  | -2.8  | 0.00696 |
| 64 | RNASE4  | -2.79 | -2.79 | 0.00707 |
| 66 | ZFP36L1 | -2.78 | -2.78 | 0.0073  |
| 65 | FGF10   | -2.78 | -4.26 | 0.0073  |
| 67 | BBS7    | -2.77 | -2.77 | 0.00741 |
| 68 | SFTPC   | -2.76 | -2.76 | 0.00752 |
| 69 | STMN3   | -2.74 | -2.74 | 0.00763 |
| 70 | PIK3CB  | -2.73 | -2.73 | 0.00774 |
| 71 | NDN     | -2.69 | -2.69 | 0.00785 |
| 72 | CDKL3   | -2.66 | -2.66 | 0.00796 |
| 73 | MKKS    | -2.65 | -2.65 | 0.00807 |
| 75 | QPRT    | -2.61 | -2.63 | 0.00829 |
| 74 | MTMR1   | -2.61 | -2.81 | 0.00829 |
| 76 | SIK3    | -2.6  | -2.6  | 0.0084  |
| 77 | FCGR2C  | -2.58 | -2.58 | 0.00851 |
| 78 | MPP1    | -2.56 | -2.56 | 0.00862 |
| 79 | KRT16   | -2.55 | -2.55 | 0.00873 |
| 81 | CYP4F3  | -2.54 | -2.79 | 0.00895 |
| 80 | OR6K6   | -2.54 | -2.69 | 0.00895 |
| 83 | NFATC1  | -2.51 | -2.85 | 0.00917 |
| 82 | JAK1    | -2.51 | -2.51 | 0.00917 |
| 84 | PLBD2   | -2.49 | -2.49 | 0.00928 |
| 85 | OR1E1   | -2.48 | -2.48 | 0.0094  |
| 89 | OR1E2   | -2.46 | -2.46 | 0.00984 |
| 88 | CCKBR   | -2.46 | -2.46 | 0.00984 |
| 87 | TDGF1P3 | -2.46 | -2.46 | 0.00984 |
| 86 | SORCS3  | -2.46 | -2.46 | 0.00984 |
| 91 | LOXL4   | -2.45 | -2.45 | 0.0101  |
| 90 | DEK     | -2.45 | -2.45 | 0.0101  |

|     |              |       |       |        |
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| 92  | KCNA2        | -2.43 | -2.43 | 0.0102 |
| 94  | ACTG2        | -2.42 | -2.42 | 0.0104 |
| 93  | MED7         | -2.42 | -2.42 | 0.0104 |
| 96  | CHST2        | -2.41 | -2.41 | 0.0106 |
| 95  | PTPN13       | -2.41 | -2.41 | 0.0106 |
| 98  | NCSTN        | -2.39 | -2.39 | 0.0108 |
| 97  | GIMAP4       | -2.39 | -2.39 | 0.0108 |
| 99  | ARHGAP23     | -2.38 | -2.38 | 0.0109 |
| 100 | HLA-DPA1     | -2.37 | -2.37 | 0.0111 |
| 101 | WDSUB1       | -2.36 | -2.36 | 0.0112 |
| 102 | KCTD3        | -2.35 | -3.03 | 0.0113 |
| 104 | SPACA5B      | -2.33 | -2.33 | 0.0115 |
| 103 | SPACA5       | -2.33 | -2.33 | 0.0115 |
| 106 | OR1E1        | -2.31 | -2.31 | 0.0117 |
| 105 | CPPED1       | -2.31 | -2.31 | 0.0117 |
| 107 | LOC100507699 | -2.3  | -2.3  | 0.0118 |
| 108 | ISCU         | -2.28 | -2.28 | 0.0119 |
| 112 | GMIP         | -2.26 | -2.26 | 0.0124 |
| 111 | HEYL         | -2.26 | -2.26 | 0.0124 |
| 110 | LOC646096    | -2.26 | -2.26 | 0.0124 |
| 109 | FCGR2A       | -2.26 | -2.26 | 0.0124 |
| 113 | STS          | -2.25 | -2.56 | 0.0125 |
| 117 | BMP2K        | -2.22 | -2.27 | 0.0129 |
| 116 | TSSK3        | -2.22 | -2.22 | 0.0129 |
| 115 | EIF2AK3      | -2.22 | -2.44 | 0.0129 |
| 114 | HS2ST1       | -2.22 | -2.22 | 0.0129 |
| 119 | ETAA1        | -2.19 | -2.19 | 0.0132 |
| 118 | HAS2         | -2.19 | -2.19 | 0.0132 |
| 120 | PKNOX2       | -2.18 | -2.18 | 0.0133 |
| 122 | RBX1         | -2.15 | -2.15 | 0.0135 |
| 121 | MAP3K7       | -2.15 | -2.15 | 0.0135 |
| 123 | SLC25A4      | -2.14 | -2.14 | 0.0136 |
| 126 | TRIM43B      | -2.13 | -2.13 | 0.0139 |
| 125 | TRIM43       | -2.13 | -2.13 | 0.0139 |
| 124 | TRAIP        | -2.13 | -2.13 | 0.0139 |
| 127 | COL9A1       | -2.12 | -2.12 | 0.014  |
| 128 | SACM1L       | -2.11 | -2.11 | 0.0141 |
| 129 | LYN          | -2.1  | -2.1  | 0.0143 |
| 130 | ANK3         | -2.09 | -2.86 | 0.0144 |
| 131 | KCNH2        | -2.08 | -2.14 | 0.0145 |
| 132 | JUB          | -2.05 | -3.23 | 0.0146 |
| 133 | BIK          | -2.04 | -2.04 | 0.0147 |
| 134 | SGPP2        | -2.03 | -2.03 | 0.0148 |
| 135 | ZNF667       | -2.01 | -2.01 | 0.0149 |
| 136 | ZAK          | -2    | -2    | 0.015  |
| 137 | SERPINA4     | -1.99 | -1.99 | 0.0151 |
| 140 | MYO3B        | -1.98 | -1.98 | 0.0155 |

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| 139 | HSFY2       | -1.98 | -1.98 | 0.0155 |
| 138 | HSFY1       | -1.98 | -1.98 | 0.0155 |
| 141 | POFUT2      | -1.96 | -1.96 | 0.0156 |
| 143 | PROCR       | -1.95 | -1.95 | 0.0158 |
| 142 | RFX5        | -1.95 | -2    | 0.0158 |
| 146 | FXVD6-FXVD2 | -1.94 | -1.94 | 0.0161 |
| 145 | ADAM28      | -1.94 | -1.94 | 0.0161 |
| 144 | ROBO1       | -1.94 | -1.94 | 0.0161 |
| 147 | NLRP12      | -1.93 | -1.93 | 0.0162 |
| 148 | SMARCD1     | -1.92 | -2.55 | 0.0164 |
| 149 | RDH8        | -1.91 | -1.91 | 0.0165 |
| 151 | CDX1        | -1.9  | -1.9  | 0.0167 |
| 150 | MAPK1       | -1.9  | -1.9  | 0.0167 |
| 152 | PRDM9       | -1.89 | -1.89 | 0.0168 |
| 154 | CIB3        | -1.88 | -1.88 | 0.017  |
| 153 | GEM         | -1.88 | -1.88 | 0.017  |
| 158 | AK4         | -1.87 | -1.87 | 0.0175 |
| 157 | ZNF514      | -1.87 | -1.87 | 0.0175 |
| 156 | FBXO6       | -1.87 | -1.87 | 0.0175 |
| 155 | SEMA6C      | -1.87 | -1.87 | 0.0175 |
| 160 | GNAT2       | -1.86 | -1.86 | 0.0177 |
| 159 | ADAM7       | -1.86 | -1.86 | 0.0177 |
| 161 | ALKBH3      | -1.85 | -1.85 | 0.0178 |
| 164 | NCOA5       | -1.84 | -2.23 | 0.0181 |
| 163 | TRPM5       | -1.84 | -2.21 | 0.0181 |
| 162 | C12orf52    | -1.84 | -1.84 | 0.0181 |
| 166 | WWOX        | -1.83 | -1.83 | 0.0183 |
| 165 | RXFP1       | -1.83 | -1.83 | 0.0183 |
| 168 | MEP1B       | -1.82 | -1.82 | 0.0186 |
| 167 | GNMT        | -1.82 | -1.82 | 0.0186 |
| 169 | PRKAR1A     | -1.81 | -1.81 | 0.0187 |
| 172 | SLC4A2      | -1.8  | -1.8  | 0.019  |
| 171 | CD96        | -1.8  | -1.8  | 0.019  |
| 170 | MEIS3       | -1.8  | -1.8  | 0.019  |
| 174 | IL17A       | -1.78 | -1.78 | 0.0192 |
| 173 | RMND5A      | -1.78 | -1.78 | 0.0192 |
| 176 | OSGEPL1     | -1.77 | -1.77 | 0.0195 |
| 175 | NACAP1      | -1.77 | -1.77 | 0.0195 |
| 179 | CYP3A4      | -1.76 | -1.76 | 0.0198 |
| 178 | HIPK1       | -1.76 | -1.76 | 0.0198 |
| 177 | NPAS1       | -1.76 | -1.76 | 0.0198 |
| 180 | AOC3        | -1.75 | -1.75 | 0.0199 |
| 181 | COL4A2      | -1.74 | -1.74 | 0.02   |
| 182 | SIX4        | -1.73 | -1.73 | 0.0201 |
| 184 | ZNF438      | -1.72 | -1.72 | 0.0203 |
| 183 | ZNF780B     | -1.72 | -1.72 | 0.0203 |
| 187 | SSH3        | -1.71 | -1.71 | 0.0207 |

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|-----|----------|-------|-------|--------|
| 186 | STRADA   | -1.71 | -1.71 | 0.0207 |
| 185 | PMF1     | -1.71 | -1.71 | 0.0207 |
| 188 | MAT2A    | -1.7  | -1.7  | 0.0208 |
| 190 | CDHR5    | -1.69 | -1.93 | 0.021  |
| 189 | SPINLW1  | -1.69 | -1.69 | 0.021  |
| 192 | ATP13A1  | -1.68 | -1.73 | 0.0212 |
| 191 | SPRED1   | -1.68 | -1.68 | 0.0212 |
| 195 | NAALAD2  | -1.67 | -1.67 | 0.0216 |
| 194 | SELPLG   | -1.67 | -1.67 | 0.0216 |
| 193 | TRAM1    | -1.67 | -1.67 | 0.0216 |
| 199 | TAF1B    | -1.66 | -1.66 | 0.022  |
| 198 | FLG2     | -1.66 | -1.66 | 0.022  |
| 197 | SKIV2L2  | -1.66 | -1.66 | 0.022  |
| 196 | SCUBE3   | -1.66 | -1.66 | 0.022  |
| 207 | RBL1     | -1.65 | -1.65 | 0.0229 |
| 206 | PHF13    | -1.65 | -1.65 | 0.0229 |
| 205 | PRSS42   | -1.65 | -1.65 | 0.0229 |
| 204 | LONRF3   | -1.65 | -1.65 | 0.0229 |
| 203 | TET1     | -1.65 | -1.89 | 0.0229 |
| 202 | TRIM48   | -1.65 | -1.65 | 0.0229 |
| 201 | PKN1     | -1.65 | -1.65 | 0.0229 |
| 200 | ATP6V1B2 | -1.65 | -1.65 | 0.0229 |
| 208 | TIAL1    | -1.64 | -1.64 | 0.023  |
| 211 | SLC7A11  | -1.63 | -1.69 | 0.0233 |
| 210 | ACMSD    | -1.63 | -1.63 | 0.0233 |
| 209 | RNF8     | -1.63 | -1.63 | 0.0233 |
| 212 | S100A8   | -1.62 | -1.62 | 0.0234 |
| 216 | PFDN1    | -1.61 | -1.61 | 0.0239 |
| 215 | ZNF37A   | -1.61 | -1.61 | 0.0239 |
| 214 | DLK1     | -1.61 | -1.61 | 0.0239 |
| 213 | SERPINA1 | -1.61 | -1.61 | 0.0239 |
| 220 | PAPD5    | -1.6  | -1.6  | 0.0243 |
| 219 | LMBRD1   | -1.6  | -2.05 | 0.0243 |
| 218 | SIM2     | -1.6  | -1.6  | 0.0243 |
| 217 | LEP      | -1.6  | -1.6  | 0.0243 |
| 222 | ZNF653   | -1.59 | -2.14 | 0.0245 |
| 221 | ZCCHC14  | -1.59 | -1.59 | 0.0245 |
| 226 | BBS4     | -1.58 | -1.58 | 0.025  |
| 225 | RAB3GAP2 | -1.58 | -2.06 | 0.025  |
| 224 | 10-Mar   | -1.58 | -1.58 | 0.025  |
| 223 | HELLS    | -1.58 | -1.58 | 0.025  |
| 229 | WFDC12   | -1.57 | -1.57 | 0.0253 |
| 228 | TNFAIP8  | -1.57 | -1.57 | 0.0253 |
| 227 | CES1P1   | -1.57 | -1.57 | 0.0253 |
| 235 | IDH2     | -1.56 | -1.56 | 0.026  |
| 234 | BCL9     | -1.56 | -1.56 | 0.026  |
| 233 | OBP2A    | -1.56 | -1.56 | 0.026  |

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| 232 | MKX     | -1.56 | -1.56 | 0.026  |
| 231 | DDX5    | -1.56 | -1.56 | 0.026  |
| 230 | LACTB   | -1.56 | -1.56 | 0.026  |
| 238 | GLRX2   | -1.55 | -1.55 | 0.0263 |
| 237 | TNRC6C  | -1.55 | -2.12 | 0.0263 |
| 236 | NKX2-1  | -1.55 | -1.55 | 0.0263 |
| 242 | FETUB   | -1.54 | -1.54 | 0.0267 |
| 241 | ZNF222  | -1.54 | -1.54 | 0.0267 |
| 240 | UCK1    | -1.54 | -1.54 | 0.0267 |
| 239 | TBC1D9B | -1.54 | -1.54 | 0.0267 |
| 246 | SP110   | -1.53 | -1.78 | 0.0272 |
| 245 | ACRBP   | -1.53 | -1.53 | 0.0272 |
| 244 | GALC    | -1.53 | -1.53 | 0.0272 |
| 243 | DNAJB6  | -1.53 | -1.53 | 0.0272 |
| 249 | CC2D1A  | -1.52 | -1.52 | 0.0275 |
| 248 | MAP3K1  | -1.52 | -1.9  | 0.0275 |
| 247 | PON1    | -1.52 | -1.52 | 0.0275 |
| 252 | EFCAB1  | -1.51 | -2.15 | 0.0279 |
| 251 | ZNF182  | -1.51 | -1.51 | 0.0279 |
| 250 | SLC38A2 | -1.51 | -1.51 | 0.0279 |
| 255 | BBOX1   | -1.5  | -1.62 | 0.0282 |
| 254 | PIK3R6  | -1.5  | -1.5  | 0.0282 |
| 253 | PCDHA13 | -1.5  | -1.5  | 0.0282 |
| 259 | SFXN2   | -1.49 | -1.49 | 0.0286 |
| 258 | ARFGAP3 | -1.49 | -1.49 | 0.0286 |
| 257 | APEH    | -1.49 | -1.53 | 0.0286 |
| 256 | DIS3    | -1.49 | -1.49 | 0.0286 |
| 262 | LAMA2   | -1.48 | -1.48 | 0.029  |
| 261 | CLK2P   | -1.48 | -1.48 | 0.029  |
| 260 | ZBTB39  | -1.48 | -1.48 | 0.029  |
| 268 | METTL4  | -1.47 | -1.47 | 0.0296 |
| 267 | ILKAP   | -1.47 | -1.47 | 0.0296 |
| 266 | TSLP    | -1.47 | -1.47 | 0.0296 |
| 265 | SLC5A12 | -1.47 | -1.47 | 0.0296 |
| 264 | CUL2    | -1.47 | -1.47 | 0.0296 |
| 263 | LEPREL2 | -1.47 | -1.47 | 0.0296 |
| 272 | S1PR2   | -1.46 | -1.46 | 0.0301 |
| 271 | DLG2    | -1.46 | -1.62 | 0.0301 |
| 270 | CNTF    | -1.46 | -1.46 | 0.0301 |
| 269 | ACADS   | -1.46 | -1.46 | 0.0301 |
| 278 | ADRA1A  | -1.45 | -1.45 | 0.0307 |
| 277 | N6AMT1  | -1.45 | -1.45 | 0.0307 |
| 276 | THEM5   | -1.45 | -1.45 | 0.0307 |
| 275 | DLX6    | -1.45 | -1.45 | 0.0307 |
| 274 | SOD1    | -1.45 | -1.45 | 0.0307 |
| 273 | MAT1A   | -1.45 | -1.45 | 0.0307 |
| 281 | ZNF645  | -1.44 | -1.44 | 0.0311 |

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|-----|-----------|-------|-------|--------|
| 280 | ZNF85     | -1.44 | -1.44 | 0.0311 |
| 279 | SFTPA1    | -1.44 | -1.44 | 0.0311 |
| 285 | PRKAG1    | -1.43 | -1.43 | 0.0315 |
| 284 | RASL11B   | -1.43 | -1.43 | 0.0315 |
| 283 | SUGT1     | -1.43 | -1.43 | 0.0315 |
| 282 | ZNF611    | -1.43 | -1.43 | 0.0315 |
| 289 | OR6V1     | -1.42 | -1.42 | 0.0319 |
| 288 | HDAC3     | -1.42 | -1.91 | 0.0319 |
| 287 | DCX       | -1.42 | -1.42 | 0.0319 |
| 286 | GLP2R     | -1.42 | -1.42 | 0.0319 |
| 294 | SLC35C2   | -1.41 | -1.41 | 0.0325 |
| 293 | FZD3      | -1.41 | -1.65 | 0.0325 |
| 292 | ZNF484    | -1.41 | -1.41 | 0.0325 |
| 291 | HDAC2     | -1.41 | -1.41 | 0.0325 |
| 290 | RAVER1    | -1.41 | -1.41 | 0.0325 |
| 304 | PKM2      | -1.4  | -1.4  | 0.0336 |
| 303 | LOC652797 | -1.4  | -1.4  | 0.0336 |
| 302 | LGALS3    | -1.4  | -1.45 | 0.0336 |
| 301 | IL22      | -1.4  | -1.59 | 0.0336 |
| 300 | NFE2L2    | -1.4  | -1.4  | 0.0336 |
| 299 | GRIA1     | -1.4  | -1.42 | 0.0336 |
| 298 | RBM26     | -1.4  | -1.4  | 0.0336 |
| 297 | SLC28A2   | -1.4  | -1.6  | 0.0336 |
| 296 | CTBP2     | -1.4  | -1.4  | 0.0336 |
| 295 | SLA       | -1.4  | -1.4  | 0.0336 |
| 312 | STX3      | -1.39 | -1.39 | 0.0345 |
| 311 | FSHR      | -1.39 | -1.39 | 0.0345 |
| 310 | RNF121    | -1.39 | -1.39 | 0.0345 |
| 309 | POLR2H    | -1.39 | -1.39 | 0.0345 |
| 308 | EFEMP1    | -1.39 | -1.39 | 0.0345 |
| 307 | FAM18A    | -1.39 | -1.39 | 0.0345 |
| 306 | GPR15     | -1.39 | -1.39 | 0.0345 |
| 305 | RNF11     | -1.39 | -1.39 | 0.0345 |
| 318 | INVS      | -1.38 | -1.49 | 0.0351 |
| 317 | PHLPP1    | -1.38 | -1.42 | 0.0351 |
| 316 | RCAN1     | -1.38 | -1.38 | 0.0351 |
| 315 | CAPN1     | -1.38 | -1.38 | 0.0351 |
| 314 | CEACAM6   | -1.38 | -1.38 | 0.0351 |
| 313 | METAP1    | -1.38 | -1.38 | 0.0351 |
| 321 | ADORA2B   | -1.37 | -1.37 | 0.0355 |
| 320 | ABCC3     | -1.37 | -1.37 | 0.0355 |
| 319 | PCDHA13   | -1.37 | -1.37 | 0.0355 |
| 324 | CAPN5     | -1.36 | -1.36 | 0.0358 |
| 323 | SCG3      | -1.36 | -1.36 | 0.0358 |
| 322 | NBEA      | -1.36 | -1.36 | 0.0358 |
| 329 | BMP6      | -1.35 | -1.35 | 0.0364 |
| 328 | GATA1     | -1.35 | -1.35 | 0.0364 |

|     |              |       |       |        |
|-----|--------------|-------|-------|--------|
| 327 | IL21R        | -1.35 | -1.35 | 0.0364 |
| 326 | FBXW11       | -1.35 | -1.35 | 0.0364 |
| 325 | USP21        | -1.35 | -1.35 | 0.0364 |
| 337 | TIE1         | -1.34 | -1.34 | 0.0372 |
| 336 | AMY2A        | -1.34 | -1.47 | 0.0372 |
| 335 | HRSP12       | -1.34 | -1.46 | 0.0372 |
| 334 | TAL1         | -1.34 | -1.34 | 0.0372 |
| 333 | CDC42BPB     | -1.34 | -1.34 | 0.0372 |
| 332 | CAMK1D       | -1.34 | -1.34 | 0.0372 |
| 331 | BCL9         | -1.34 | -1.34 | 0.0372 |
| 330 | HAAO         | -1.34 | -1.34 | 0.0372 |
| 342 | ZNF76        | -1.33 | -1.33 | 0.0378 |
| 341 | MATR3        | -1.33 | -1.33 | 0.0378 |
| 340 | MXD4         | -1.33 | -1.33 | 0.0378 |
| 339 | PCSK1        | -1.33 | -1.33 | 0.0378 |
| 338 | ZSCAN4       | -1.33 | -1.33 | 0.0378 |
| 347 | NHP2L1       | -1.32 | -1.32 | 0.0384 |
| 346 | PC           | -1.32 | -1.32 | 0.0384 |
| 345 | PRDM2        | -1.32 | -1.32 | 0.0384 |
| 344 | HIST1H2BB    | -1.32 | -1.67 | 0.0384 |
| 343 | CNOT8        | -1.32 | -1.32 | 0.0384 |
| 353 | LOC440563    | -1.31 | -1.31 | 0.039  |
| 352 | TRPT1        | -1.31 | -1.91 | 0.039  |
| 351 | RSC1A1       | -1.31 | -1.36 | 0.039  |
| 350 | DNAJC27      | -1.31 | -1.31 | 0.039  |
| 349 | SLC6A8       | -1.31 | -1.31 | 0.039  |
| 348 | ZNF585A      | -1.31 | -1.31 | 0.039  |
| 364 | NINL         | -1.3  | -1.3  | 0.0402 |
| 363 | GLUL         | -1.3  | -1.3  | 0.0402 |
| 362 | LOC100507804 | -1.3  | -1.3  | 0.0402 |
| 361 | SIRPG        | -1.3  | -1.3  | 0.0402 |
| 360 | SLC41A1      | -1.3  | -1.3  | 0.0402 |
| 359 | RDX          | -1.3  | -1.3  | 0.0402 |
| 358 | GLUD1        | -1.3  | -1.3  | 0.0402 |
| 357 | TGFBR1       | -1.3  | -1.3  | 0.0402 |
| 356 | CLEC3A       | -1.3  | -1.3  | 0.0402 |
| 355 | ITGA3        | -1.3  | -1.51 | 0.0402 |
| 354 | GPR39        | -1.3  | -1.3  | 0.0402 |
| 369 | PGM2         | -1.29 | -1.29 | 0.0408 |
| 368 | CDH7         | -1.29 | -1.29 | 0.0408 |
| 367 | PSIP1        | -1.29 | -1.29 | 0.0408 |
| 366 | S100A14      | -1.29 | -1.29 | 0.0408 |
| 365 | PZP          | -1.29 | -1.58 | 0.0408 |
| 376 | BUB1         | -1.28 | -1.28 | 0.0416 |
| 375 | ZNF585B      | -1.28 | -1.6  | 0.0416 |
| 374 | DOCK2        | -1.28 | -1.28 | 0.0416 |
| 373 | ZNF524       | -1.28 | -1.28 | 0.0416 |

|     |              |       |       |        |
|-----|--------------|-------|-------|--------|
| 372 | UGT1A3       | -1.28 | -1.28 | 0.0416 |
| 371 | GYS1         | -1.28 | -1.28 | 0.0416 |
| 370 | SOCS5        | -1.28 | -1.28 | 0.0416 |
| 385 | FOS          | -1.27 | -1.27 | 0.0426 |
| 384 | PPIL3        | -1.27 | -1.27 | 0.0426 |
| 383 | PRDM7        | -1.27 | -1.27 | 0.0426 |
| 382 | ACOT11       | -1.27 | -1.43 | 0.0426 |
| 381 | CCRL1        | -1.27 | -1.27 | 0.0426 |
| 380 | PRMT8        | -1.27 | -1.27 | 0.0426 |
| 379 | OSCAR        | -1.27 | -1.27 | 0.0426 |
| 378 | LHX8         | -1.27 | -1.27 | 0.0426 |
| 377 | ROBO3        | -1.27 | -1.27 | 0.0426 |
| 393 | COBL         | -1.26 | -1.26 | 0.0434 |
| 392 | OR1E2        | -1.26 | -1.26 | 0.0434 |
| 391 | UBE2Q1       | -1.26 | -1.26 | 0.0434 |
| 390 | LDHC         | -1.26 | -1.76 | 0.0434 |
| 389 | THOC3        | -1.26 | -1.26 | 0.0434 |
| 388 | LOC728554    | -1.26 | -1.26 | 0.0434 |
| 387 | DPCR1        | -1.26 | -1.28 | 0.0434 |
| 386 | ZFP91-CNTF   | -1.26 | -1.26 | 0.0434 |
| 399 | CTRL         | -1.25 | -1.25 | 0.0441 |
| 398 | UBE2G2       | -1.25 | -1.25 | 0.0441 |
| 397 | ETV1         | -1.25 | -1.25 | 0.0441 |
| 396 | PDP1         | -1.25 | -1.25 | 0.0441 |
| 395 | YKT6         | -1.25 | -1.25 | 0.0441 |
| 394 | REM2         | -1.25 | -1.25 | 0.0441 |
| 405 | SLC27A2      | -1.24 | -1.24 | 0.0448 |
| 404 | SNRPF        | -1.24 | -1.24 | 0.0448 |
| 403 | MS4A1        | -1.24 | -1.65 | 0.0448 |
| 402 | SEC23A       | -1.24 | -1.24 | 0.0448 |
| 401 | POLL         | -1.24 | -1.24 | 0.0448 |
| 400 | SNRPA        | -1.24 | -1.24 | 0.0448 |
| 413 | SLC17A4      | -1.23 | -1.23 | 0.0457 |
| 412 | ALG10        | -1.23 | -1.23 | 0.0457 |
| 411 | LOC100290936 | -1.23 | -1.23 | 0.0457 |
| 410 | UGT1A7       | -1.23 | -1.23 | 0.0457 |
| 409 | MED27        | -1.23 | -1.23 | 0.0457 |
| 408 | CRSP8P       | -1.23 | -1.23 | 0.0457 |
| 407 | BHLHE41      | -1.23 | -1.23 | 0.0457 |
| 406 | MC5R         | -1.23 | -1.23 | 0.0457 |
| 421 | LENG1        | -1.22 | -1.3  | 0.0465 |
| 420 | ENOX2        | -1.22 | -1.22 | 0.0465 |
| 419 | GPR148       | -1.22 | -2.14 | 0.0465 |
| 418 | GPR179       | -1.22 | -1.22 | 0.0465 |
| 417 | APOB         | -1.22 | -1.22 | 0.0465 |
| 416 | BCO2         | -1.22 | -1.22 | 0.0465 |
| 415 | Luciferase   | -1.22 | -1.31 | 0.0465 |



|     |             |       |       |        |
|-----|-------------|-------|-------|--------|
| 414 | CSN3        | -1.22 | -1.22 | 0.0465 |
| 426 | HLA-DRB5    | -1.21 | -1.56 | 0.0471 |
| 425 | ST6GALNAC6  | -1.21 | -1.21 | 0.0471 |
| 424 | A4GALT      | -1.21 | -1.21 | 0.0471 |
| 423 | HSD17B7     | -1.21 | -1.21 | 0.0471 |
| 422 | RALY        | -1.21 | -1.21 | 0.0471 |
| 434 | OPN4        | -1.2  | -1.2  | 0.048  |
| 433 | RARS2       | -1.2  | -1.22 | 0.048  |
| 432 | TAF1L       | -1.2  | -1.2  | 0.048  |
| 431 | ZNF813      | -1.2  | -1.2  | 0.048  |
| 430 | DDI2        | -1.2  | -1.32 | 0.048  |
| 429 | CALCRL      | -1.2  | -1.27 | 0.048  |
| 428 | AGTR1       | -1.2  | -1.2  | 0.048  |
| 427 | DDX59       | -1.2  | -1.2  | 0.048  |
| 439 | RAB4B-EGLN2 | -1.19 | -1.19 | 0.0485 |
| 438 | CUTC        | -1.19 | -1.2  | 0.0485 |
| 437 | WISP1       | -1.19 | -1.19 | 0.0485 |
| 436 | UBR2        | -1.19 | -1.19 | 0.0485 |
| 435 | BBX         | -1.19 | -1.19 | 0.0485 |
| 444 | OR2AT4      | -1.18 | -1.18 | 0.0491 |
| 443 | ZBTB22      | -1.18 | -1.18 | 0.0491 |
| 442 | ZNF286A     | -1.18 | -1.18 | 0.0491 |
| 441 | LMBR1       | -1.18 | -1.18 | 0.0491 |
| 440 | CLCA4       | -1.18 | -1.74 | 0.0491 |
| 448 | MUSK        | -1.17 | -1.17 | 0.0495 |
| 447 | RARA        | -1.17 | -1.17 | 0.0495 |
| 446 | AGAP7       | -1.17 | -1.17 | 0.0495 |
| 445 | MATN3       | -1.17 | -1.27 | 0.0495 |

**Table 3: List of Candidate Metastatic Essential Gene by Signal-to-noise Statistic**

| Cell Line Name     |                       | BT20         | EFM19    | HCC1187  | HCC1395  | HCC1954  | HCC70    | BT474    | CAL51    | HCC2218  | MCF7    | MDAMB45  | ZR7530   |
|--------------------|-----------------------|--------------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|----------|
| 70-Genes Signature |                       | Yes          | Yes      | Yes      | Yes      | Yes      | Yes      | No       | No       | No       | No      | No       | No       |
| Gene Name          | Signal-to-noise Score | ATARIS Score |          |          |          |          |          |          |          |          |         |          |          |
| DCTN4              | -2.2624               | -0.318       | -0.4936  | -0.302   | -0.2737  | -0.3772  | -0.5605  | 0.09909  | 0.1799   | -0.02289 | 0.03791 | 0.05991  | -0.03345 |
| ZBTB32             | -2.0071               | -0.2583      | -0.5856  | -0.2289  | -0.06078 | -0.02804 | 0.01365  | 0.8407   | 0.368    | 1.0883   | 1.1047  | 0.6816   | 1.1615   |
| NT5C2              | -1.6755               | -0.1696      | -0.07164 | -0.06334 | -0.2341  | -0.329   | -0.08523 | 0.1039   | 0.6883   | 0.9598   | 0.6816  | 0.4009   | 0.3477   |
| FAM108B1           | -1.4587               | 0.02436      | -0.7113  | -0.2887  | -0.1976  | -0.642   | -0.2231  | 0.395    | 0.1796   | 0.8664   | 0.6361  | 0.4263   | 0.2133   |
| RFK                | -1.3948               | -0.2018      | -0.2454  | -0.3741  | -0.1261  | -0.03628 | 0.2843   | 0.2219   | 0.3156   | 0.3571   | 0.3891  | 0.3948   | 0.2081   |
| OSTM1              | -1.3921               | -0.3141      | -0.9178  | -0.1645  | -0.5739  | -0.609   | -0.2478  | 0.7982   | 1.0991   | 0.2714   | 0.5404  | -0.08168 | 0.3627   |
| PVRL4              | -1.3893               | -0.5309      | -0.1334  | -0.1419  | 0.000791 | 0.008157 | 0.4624   | 0.9066   | 0.8232   | 0.6386   | 0.9186  | 0.6391   | 0.3161   |
| LOC100508181       | -1.3628               | -0.377       | -0.2222  | -0.7817  | -0.4498  | -0.8929  | -0.1806  | -0.09554 | 0.5338   | 0.3572   | 0.6689  | 0.455    | 1.3007   |
| PHTF2              | -1.3514               | -0.7464      | -0.8072  | -1.1498  | -1.0324  | -0.1776  | -0.7285  | 0.5249   | 0.9114   | -0.1641  | 0.4402  | -0.2717  | 0.2513   |
| WIF1               | -1.304                | -0.1702      | -0.2403  | -0.2197  | -0.2732  | -0.6575  | -0.4135  | 1.1143   | 1.5252   | 0.6988   | 0.2255  | 1.3606   | -0.2011  |
| TP53BP1            | -1.288                | -0.1846      | -0.5797  | -0.2311  | -0.8134  | -0.4119  | -1.1359  | 0.2287   | 0.7956   | 0.8082   | 0.9954  | -0.2576  | 1.356    |
| S100B              | -1.2815               | -0.08959     | 0.1526   | -0.4528  | -0.575   | -0.8274  | -0.3823  | 0.4518   | 0.5197   | 0.3886   | 0.7411  | 0.5052   | -0.05845 |
| SLC4A1             | -1.2788               | -0.00511     | -0.555   | -0.6021  | -0.04958 | -0.02566 | -0.7011  | 0.6929   | 0.5044   | 0.2312   | 1.3352  | 0.3757   | 0.4478   |
| LOC100287382       | -1.2613               | -0.3308      | -0.839   | -0.4706  | -0.3261  | -0.7016  | -0.3466  | -0.09612 | 0.8371   | 0.4843   | -0.2486 | 1.1318   | 1.2009   |
| LOC729468          | -1.2613               | -0.3308      | -0.839   | -0.4706  | -0.3261  | -0.7016  | -0.3466  | -0.09612 | 0.8371   | 0.4843   | -0.2486 | 1.1318   | 1.2009   |
| IARS2              | -1.2509               | -0.05346     | 0.06541  | 0.4868   | -1.0062  | -0.3682  | -1.0901  | 0.6326   | 0.9987   | 0.6422   | 0.504   | 0.9302   | 0.5442   |
| ATP5G3             | -1.2468               | -0.8917      | 1.2115   | -0.6805  | -0.3316  | -0.8658  | 0.3118   | 1.5166   | 0.8323   | 1.4779   | 1.8681  | 1.1969   | 0.952    |
| RGS1               | -1.2252               | -0.03815     | -0.4062  | 0.141    | -0.3341  | 0.04471  | 0.2495   | 1.1098   | 0.07418  | 0.8325   | 1.2625  | 0.9447   | 0.5298   |
| LUC7L2             | -1.2211               | -1.4671      | -0.549   | -1.6618  | -0.692   | -1.0385  | -0.6638  | -0.2341  | -0.3331  | 0.09799  | -0.2362 | 0.5445   | -0.1364  |
| CALM3              | -1.2158               | 0.1407       | 0.5725   | 0.1133   | -0.4799  | -0.3698  | -0.08024 | 2.1174   | 0.2159   | 1.2258   | 0.9093  | 1.4326   | 1.3774   |
| BCAS2              | -1.2067               | 0.1384       | -0.4195  | -0.1391  | -0.4953  | -0.3784  | -0.2387  | 0.4289   | 0.1672   | 0.571    | 0.394   | 0.172    | -0.02049 |
| GZMB               | -1.1813               | 0.06754      | -0.4567  | -0.2928  | -0.732   | -0.7981  | -0.2524  | 0.4427   | 0.8883   | 0.07665  | 0.05294 | 0.1516   | 0.5272   |
| CD55               | -1.1711               | 0.09329      | 0.2052   | 0.0833   | 0.6462   | -0.67    | 0.1478   | 0.9077   | 0.8461   | 0.4733   | 0.8587  | 0.7133   | 0.8043   |
| PTPRJ              | -1.142                | -0.2062      | -0.5638  | -0.4748  | -0.7498  | -0.4758  | -0.255   | -0.2148  | 0.8215   | 0.6478   | 0.2922  | 0.1362   | -0.1566  |
| C5orf32            | -1.1371               | -0.3591      | -0.579   | -0.2549  | -0.2004  | -0.1023  | -0.5074  | -0.3285  | 0.4403   | 0.1733   | 0.2867  | 0.8766   | 0.6227   |
| MED7               | -1.1343               | -0.6802      | -0.6569  | 0.5217   | -0.143   | -0.3669  | -0.7093  | 0.9398   | -0.1106  | 1.06     | 0.4999  | 1.421    | 1.1018   |
| HNRNP1             | -1.1174               | -0.2305      | -0.5734  | 0.2215   | -0.0224  | -0.5414  | -0.9525  | 0.224    | 0.3902   | 0.6846   | 0.7473  | 0.1371   | 0.2589   |
| FGF10              | -1.1106               | 0.2459       | 0.6287   | -0.3492  | 0.1717   | 0.4935   | 0.3517   | 0.9904   | 0.685    | 0.5333   | 0.9329  | 0.9828   | 0.9654   |
| ALDOA              | -1.1074               | -0.2787      | -0.07435 | -0.711   | -0.2363  | -0.5584  | -0.8404  | -0.03431 | 0.05221  | 0.08522  | -0.1594 | 0.302    | 0.05592  |
| SPOCK1             | -1.0676               | 0.3131       | 0.3557   | -0.06346 | -0.3052  | -0.4793  | -0.5039  | 0.3763   | 0.5754   | 0.9232   | 0.88    | 1.6092   | 0.3783   |
| MPP1               | -1.0603               | -0.5978      | 0.2773   | 0.02013  | -0.02638 | -0.2616  | -0.1441  | 0.4018   | -0.06545 | 1.0462   | 0.6627  | 0.898    | 0.7296   |
| ZNF628             | -1.0563               | -0.4923      | 0.2394   | -1.118   | -0.2734  | -0.4175  | -0.5068  | 0.6386   | 0.1438   | 0.1536   | 1.1882  | 0.4705   | 0.189    |
| TNK1               | -1.0537               | 0.2132       | -0.5604  | -0.01147 | -0.2994  | -0.7978  | -0.1586  | 0.7894   | -0.03349 | 0.4538   | 1.2535  | 0.5806   | 0.3883   |
| THBS2              | -1.0412               | -0.1867      | 0.497    | 0.2514   | -0.9225  | -0.7343  | 0.413    | 0.9049   | 0.7682   | 1.7451   | 1.4029  | 0.8286   | 0.4262   |

|           |         |          |          |          |          |          |          |         |          |         |          |          |          |
|-----------|---------|----------|----------|----------|----------|----------|----------|---------|----------|---------|----------|----------|----------|
| LOC649330 | -1.0376 | 0.152    | 0.1061   | -0.6511  | 0.3264   | -0.9751  | 0.2559   | 0.38    | 0.4463   | 1.1044  | 0.714    | 0.8183   | 0.7872   |
| QPR1      | -1.0368 | -0.0355  | 0.633    | 0.1523   | -0.1402  | -0.00864 | -0.6937  | 0.4527  | 0.3899   | 0.7881  | 0.6249   | 0.7883   | 0.572    |
| BCL2      | -1.0297 | -0.02005 | -0.1732  | -1.0036  | -0.5859  | -1.2245  | -0.4009  | 0.07825 | -0.123   | 0.4698  | 0.2207   | 0.3183   | -0.06018 |
| KHDRBS2   | -1.0285 | -0.159   | 0.4294   | 0.52     | -0.1529  | -0.1827  | 0.312    | 0.4349  | 0.6545   | 0.9413  | 0.7556   | 0.97     | 0.4554   |
| SPACA5B   | -1.0212 | -0.2272  | 0.2335   | -0.3711  | -0.2251  | -0.01164 | -0.3672  | 0.7953  | 0.3835   | 0.4754  | -0.07964 | 0.6019   | 0.1841   |
| SPACA5    | -1.0212 | -0.2272  | 0.2335   | -0.3711  | -0.2251  | -0.01164 | -0.3672  | 0.7953  | 0.3835   | 0.4754  | -0.07964 | 0.6019   | 0.1841   |
| STS       | -1.0166 | -0.2496  | 0.3639   | 0.06765  | -0.2398  | 0.2402   | 0.3594   | 1.1138  | 0.9974   | 0.1336  | 0.7811   | 1.2827   | 0.5227   |
| OR1E2     | -1.0112 | -0.3545  | -1.0026  | -0.3919  | -0.469   | 0.3651   | -0.5699  | 0.1136  | 0.8556   | 0.2822  | 0.9296   | -0.03069 | 0.4975   |
| ELAC1     | -1.0111 | -0.429   | 0.2961   | 0.002348 | -0.1516  | -0.2352  | 0.2474   | 0.1466  | 0.8395   | 0.3581  | 0.5056   | 0.5294   | 1.0558   |
| IRS2      | -1.01   | -0.25    | -0.07062 | 0.1095   | 0.3364   | -0.536   | -0.4052  | 0.1898  | 0.7247   | 0.9558  | 0.1394   | 0.8794   | 0.4104   |
| MTHFD1L   | -1.0092 | -0.08922 | -0.3717  | -0.4063  | 0.4791   | -0.1318  | 0.1866   | 1.6859  | 0.3567   | 1.2365  | 0.6359   | 0.5859   | 0.4132   |
| STMN3     | -1.0085 | -0.6944  | -0.4611  | 0.2687   | 0.2725   | -0.3095  | 0.07688  | 1.2688  | 0.1119   | 0.8019  | 1.017    | 0.9069   | 0.2444   |
| HNRNPA3P1 | -1.0062 | -0.4412  | -0.7012  | -0.6582  | -0.4444  | -0.3759  | -0.8464  | 0.333   | -0.2111  | 0.4616  | 0.5911   | -0.4539  | -0.3452  |
| DEK       | -1.0058 | 0.04381  | -0.6619  | -0.3711  | -0.5309  | -0.6584  | -0.3157  | 0.1017  | 0.03372  | 0.3299  | 0.7416   | 0.3409   | -0.3044  |
| GIMAP4    | -1.0043 | 0.09524  | -0.4198  | -0.3343  | 0.4586   | -0.7514  | -0.06557 | 0.7257  | 0.7721   | 0.1017  | 0.6474   | 0.9131   | 0.2776   |
| OR2T10    | -1.0022 | -1.2949  | -0.5235  | -0.1998  | -1.2162  | -0.3228  | -1.1919  | -0.2586 | -0.2665  | 0.1982  | -0.04531 | -0.2483  | -0.02238 |
| ETAA1     | -1.0015 | -0.5055  | 0.552    | -0.2278  | -0.5381  | -0.5482  | -0.4341  | 0.8744  | 0.2753   | 0.4249  | -0.03604 | 1.2434   | 1.0269   |
| LOXL4     | -0.9973 | -0.4178  | 0.1593   | -0.4147  | -0.1708  | -0.3341  | 0.09472  | 0.5006  | 0.007777 | 0.2968  | 0.3461   | 0.2397   | 0.1044   |
| ATP6AP2   | -0.9972 | -0.438   | -0.2838  | 0.2288   | -0.4908  | -0.1397  | -0.5741  | 0.03743 | 1.0194   | 0.1981  | 0.0126   | 0.9313   | 0.5245   |
| BMP2K     | -0.9933 | -0.2447  | 0.6884   | 0.02093  | -0.2612  | -0.1494  | 0.1028   | 0.6572  | 1.2514   | 0.2855  | 0.4457   | 0.7464   | 1.0541   |
| INHBA     | -0.9906 | -0.5492  | 0.04904  | 0.05972  | 0.002176 | -0.6477  | -1.0968  | 0.1963  | 0.05847  | 1.9354  | 1.6573   | 0.4315   | 1.0412   |
| SIK3      | -0.9899 | 0.2218   | -0.1492  | -0.6755  | 0.008296 | -0.7441  | 0.02186  | 0.6332  | -0.1987  | 0.9175  | 1.2276   | 0.5774   | 1.6632   |
| ZNF653    | -0.9878 | 0.3144   | -0.00264 | -0.00115 | 0.1078   | 0.8533   | -0.071   | 1.2267  | 0.2327   | 1.1145  | 1.0206   | 1.694    | 0.8287   |
| MKKS      | -0.9871 | -0.1508  | 0.09938  | -1.164   | -0.3427  | 0.7237   | 0.1077   | 1.8592  | 0.1511   | 0.5517  | 1.34     | 2.236    | 1.5065   |
| NCOA5     | -0.9866 | -0.3437  | 0.5561   | -0.05456 | 1.0158   | 0.04703  | -0.1564  | 1.2714  | 0.4207   | 1.2063  | 1.2374   | 0.8925   | 1.8525   |
| PRSS55    | -0.9858 | -0.3062  | -0.5494  | -0.7738  | -0.4992  | -0.5374  | -0.3053  | -0.3332 | 0.264    | -0.2366 | -0.1013  | 0.04535  | -0.2505  |
| KCNK2     | -0.9663 | 0.3908   | 0.18     | -0.3399  | -0.1441  | 0.3333   | -0.2186  | 0.3178  | 0.4927   | 0.5844  | 1.2937   | 0.6073   | 0.6235   |
| HEYL      | -0.9643 | -0.5797  | -0.3529  | 0.2138   | -0.6252  | -0.5289  | -0.1681  | 0.233   | 0.02687  | 0.00844 | 0.001798 | 0.2284   | 0.5584   |
| SLC25A4   | -0.9562 | -0.3882  | 0.366    | -1.1156  | -0.7018  | -0.9633  | 0.2647   | 0.329   | 0.5186   | 0.1567  | 0.4302   | 0.1091   | 0.4847   |
| CYP4F3    | -0.955  | 0.01543  | 0.05493  | 0.1739   | 0.4291   | -0.5873  | -0.04773 | 0.9042  | 0.2481   | 1.0369  | 1.6475   | 1.2257   | 0.1741   |
| TMEM33    | -0.9515 | -0.7469  | 0.08707  | -1.0524  | -0.7109  | 0.004322 | -0.157   | 0.05757 | 0.7661   | 0.2467  | 0.1596   | 0.02128  | 0.6636   |
| KRT16     | -0.9502 | -0.6608  | -0.2779  | -0.02271 | -0.1444  | -0.3345  | -0.1644  | 0.3439  | 0.16     | 0.1484  | -0.2141  | 0.181    | 0.0861   |
| MAP3K7    | -0.9493 | -0.2093  | -0.9974  | 0.2219   | -0.8577  | -0.77    | -0.6456  | -0.2141 | 1.1822   | 0.7164  | -0.2156  | 0.8316   | 0.3389   |
| PLBD2     | -0.9491 | -0.2463  | -0.2347  | -0.887   | 0.02721  | -0.6655  | -0.7544  | 0.2292  | -0.1541  | 0.01257 | 0.1603   | 0.1265   | -0.156   |
| PRDM9     | -0.9427 | -0.436   | -0.5525  | -0.3706  | 0.4654   | -0.2426  | -0.3193  | 0.415   | 0.5711   | 0.7457  | 0.3111   | -0.1847  | 0.5792   |
| OR1E1     | -0.9352 | -0.2936  | -0.4809  | -0.3435  | 0.2311   | 0.2958   | -0.5748  | 0.07633 | 0.2547   | 1.0743  | 0.8301   | 0.2201   | 1.2764   |
| HSFY2     | -0.929  | -0.2511  | -0.2409  | -0.07122 | 0.5799   | -0.6468  | -0.0814  | 0.5668  | 0.1749   | 0.7384  | 0.1942   | 0.5367   | 0.8349   |
| HSFY1     | -0.929  | -0.2511  | -0.2409  | -0.07122 | 0.5799   | -0.6468  | -0.0814  | 0.5668  | 0.1749   | 0.7384  | 0.1942   | 0.5367   | 0.8349   |
| POFUT2    | -0.9288 | -0.5312  | -0.1118  | -0.6164  | -0.327   | 0.08861  | -0.3937  | 0.4906  | 0.3945   | 0.2275  | 0.3827   | -0.2953  | 0.0206   |

|           |         |          |          |          |          |          |          |          |          |          |          |          |          |
|-----------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| JAK1      | -0.9252 | -0.788   | -0.4826  | 0.001783 | -0.6283  | -1.0785  | -0.926   | 0.4823   | 1.3645   | -0.5433  | 0.0145   | 1.1077   | -0.1027  |
| SORCS3    | -0.9225 | -0.6254  | 0.1014   | 0.2935   | 0.02857  | -0.9789  | -0.4308  | 0.1905   | -0.00055 | 0.6112   | 0.5898   | 0.5995   | 0.5751   |
| ZNF347    | -0.9192 | -0.2239  | 0.3248   | 0.1057   | -0.3818  | 0.3312   | -0.1019  | 0.6294   | 0.9733   | 0.3481   | 0.7983   | 0.2367   | 0.3221   |
| HLA-DPA1  | -0.9146 | -0.7395  | -0.05219 | -0.5401  | -0.6219  | -0.6395  | -0.08486 | 0.0849   | -0.3679  | 0.07228  | 0.1628   | 0.9708   | 0.6372   |
| SSX1      | -0.9142 | -0.6024  | 0.1673   | -0.1777  | 0.1718   | -1.432   | -0.1439  | 0.203    | 0.5685   | 0.531    | 0.2196   | 0.2403   | 0.503    |
| NFATC1    | -0.9137 | 0.4437   | 0.4252   | -0.1254  | 0.1666   | -0.5468  | -0.1483  | 0.9881   | 0.5118   | 1.3982   | 0.2402   | 0.5473   | 0.8972   |
| SMAD9     | -0.9131 | -0.04064 | 0.195    | 0.03278  | -0.189   | -0.1565  | -0.02548 | 0.2939   | 1.0298   | 0.3544   | 0.4575   | 0.1841   | 0.08625  |
| CNTNAP1   | -0.9069 | -0.2479  | 0.3218   | -0.8693  | -0.5201  | -1.2573  | -0.4684  | 0.532    | 0.1847   | 0.7495   | 1.9218   | 0.128    | 0.1326   |
| TDGF1P3   | -0.9066 | -0.259   | -0.4146  | -0.837   | -0.1698  | 0.2131   | -0.1611  | 0.02018  | 0.5213   | 0.2198   | 0.488    | -0.01983 | 0.2558   |
| ARHGAP23  | -0.9041 | -0.4608  | -0.2598  | -0.7333  | -1.0639  | -0.2018  | -0.6803  | -0.5041  | 0.8722   | 0.886    | 0.491    | 0.0325   | -0.2448  |
| ISCU      | -0.9034 | -1.1206  | -0.3599  | 0.1981   | -0.4515  | -1.3097  | -0.4336  | -0.234   | 0.4493   | -0.08653 | 0.3373   | 0.4054   | 0.1519   |
| TSSK3     | -0.903  | -0.05406 | 0.1876   | -0.1909  | -0.1447  | 0.08278  | -0.6313  | 0.6474   | -0.1135  | 0.2844   | 0.5834   | 0.3865   | 0.5013   |
| HAS2      | -0.9001 | 0.2446   | -0.1577  | -0.1059  | -0.2405  | -0.7684  | -0.4783  | 0.4327   | 0.6003   | 1.0902   | 0.1656   | -0.2159  | 0.7567   |
| GUCY1B2   | -0.8999 | -0.02461 | -0.08114 | -0.2109  | 0.2529   | -0.09758 | -0.7173  | 1.4007   | 1.2881   | 0.3708   | 0.2492   | 0.1858   | 0.3339   |
| CHST2     | -0.8964 | -0.62    | -0.8136  | -1.0456  | -0.4455  | -0.7234  | -0.05619 | 0.7101   | -0.3793  | 0.1438   | -0.2657  | 0.03422  | -0.05383 |
| KCNH2     | -0.891  | 0.1186   | -0.286   | -0.351   | -0.04386 | 0.5854   | 0.03692  | 0.7516   | 0.458    | 0.2074   | 1.1246   | 1.1076   | 0.3233   |
| NDN       | -0.8909 | -0.1135  | -0.06623 | -0.1725  | -0.7369  | -0.4923  | -0.1763  | -0.0907  | 0.6249   | -0.2002  | 0.3442   | 0.5242   | 0.2139   |
| FCGR2C    | -0.8854 | 0.3447   | 0.2526   | -0.7514  | -0.1467  | -0.1062  | -0.1303  | 0.7331   | 0.488    | 0.06276  | 0.5445   | 0.4272   | 1.1133   |
| CCKBR     | -0.8829 | -0.183   | 0.4555   | 0.1096   | -0.09971 | -0.2608  | -0.7715  | 0.6435   | 0.3876   | 0.1093   | 1.1226   | 0.7027   | 0.3268   |
| PRMT1     | -0.8827 | -0.3059  | -0.8947  | -0.451   | -0.3846  | -0.3485  | -1.1205  | -0.1205  | 0.3352   | -0.2397  | 0.5905   | -0.2745  | -0.1329  |
| ADAM7     | -0.8823 | -0.08114 | -0.00375 | 0.03595  | 0.07085  | -0.5074  | -0.2763  | 0.5238   | -0.3775  | 1.169    | 1.1898   | 0.2703   | 0.8099   |
| SMARCAD1  | -0.8811 | 0.1636   | 0.427    | 0.09491  | -0.3018  | 0.2798   | 0.3594   | 0.9993   | 0.387    | 1.3924   | 0.2219   | 0.6802   | 1.0649   |
| LOC646096 | -0.8784 | -0.4516  | -1.2004  | -0.2208  | -0.7553  | -1.0455  | -0.08071 | -0.3634  | 0.2002   | 0.4003   | -0.1402  | 0.3      | -0.1725  |
| KCTD3     | -0.8773 | -0.5419  | 0.7069   | 0.336    | 0.474    | 0.1299   | -0.1027  | 1.3342   | 0.4539   | 0.7225   | 0.6941   | 1.0666   | 0.7263   |
| AK4       | -0.8743 | -0.4988  | -0.01355 | 0.03943  | 0.2435   | -0.3927  | -0.1874  | 0.6459   | 0.241    | -0.2589  | 0.8344   | 0.5989   | 1.0974   |
| ZAK       | -0.8734 | -0.2996  | -0.3215  | -0.5759  | -0.4586  | -0.8363  | 0.4522   | -0.06398 | 0.3035   | 0.9732   | 0.1166   | 0.2589   | 0.578    |
| ZFP112    | -0.8732 | -0.4034  | 0.08263  | -0.786   | -0.507   | -0.3706  | -0.9178  | 0.4606   | -0.05077 | -0.1224  | 1.2369   | -0.01075 | 0.1284   |
| GEM       | -0.8705 | 0.000266 | 0.1298   | -0.2331  | -0.4972  | 0.009087 | -0.2214  | 0.6311   | -0.2485  | 0.8124   | 0.1155   | 1.0966   | 0.5001   |
| SLC4A2    | -0.8691 | -0.2307  | 0.4293   | 0.0937   | -0.2428  | 0.08082  | -0.3268  | 0.3014   | 0.4292   | 0.1227   | 0.2592   | 0.4235   | 0.3758   |
| CDKL3     | -0.8677 | 0.01495  | -0.4701  | -0.52    | -1.0856  | 0.05194  | -0.2966  | 0.4158   | 1.0575   | -0.03004 | 0.2643   | 0.6228   | -0.1513  |
| SGPP2     | -0.8676 | 0.3994   | 0.1113   | -0.7542  | -0.229   | -0.3423  | -0.8946  | 0.1313   | 0.1744   | 0.3307   | 0.5913   | 0.1539   | 0.4889   |
| TRPT1     | -0.8653 | 0.2755   | -0.01972 | 0.6692   | 0.1341   | -0.1689  | 0.3653   | 0.7846   | 0.6886   | 0.536    | 0.2699   | 0.8549   | 0.9899   |
| SPI1      | -0.8634 | -0.364   | 0.242    | 0.1831   | -0.434   | 0.03358  | -0.1936  | 0.2793   | 0.5092   | 1.1288   | 0.6595   | 0.1219   | 0.1893   |
| LMBRD1    | -0.8591 | 0.4219   | -0.07318 | 0.2687   | 0.1867   | 0.4365   | -0.4271  | 0.9591   | 0.1248   | 0.7962   | 0.539    | 0.7897   | 1.0696   |
| GNMT      | -0.8591 | -0.3175  | -0.2979  | 0.5429   | -0.155   | -0.1529  | -0.6484  | 0.1773   | 0.01117  | 0.8228   | 0.7036   | 0.7563   | 0.2962   |
| NCSTN     | -0.8577 | -0.6271  | -0.3205  | -0.5371  | -0.09105 | 0.08072  | -0.1235  | 0.4527   | 0.1603   | 0.7587   | -0.09001 | -0.1003  | 0.3245   |
| TRPM5     | -0.8573 | 0.5395   | 0.1463   | 0.07352  | 0.405    | -0.2663  | -0.4435  | 0.9757   | 0.2467   | 0.8632   | 0.5937   | 1.2628   | 0.4071   |
| GRIK4     | -0.8553 | -0.798   | -0.3813  | -0.479   | 0.3214   | 0.2091   | -0.178   | 0.4757   | 0.2398   | 0.237    | 0.4012   | 1.1189   | 0.193    |
| RAB3GAP2  | -0.8535 | 0.6271   | 0.8084   | -0.6499  | 0.1178   | 0.08154  | -0.00181 | 0.8877   | 0.764    | 0.5798   | 0.633    | 0.6046   | 0.9416   |

|              |         |          |          |          |          |          |          |          |          |          |          |         |          |
|--------------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|
| RFX5         | -0.8533 | -0.4237  | 0.8173   | -0.2596  | -0.05957 | -0.235   | 0.3643   | 0.796    | 0.5993   | 0.2916   | 1.5675   | 1.0217  | 0.5937   |
| ACTG2        | -0.8532 | -0.2631  | -0.279   | -0.2733  | -0.5864  | -0.918   | -0.5017  | 0.6631   | -0.1971  | 0.9894   | 0.2123   | -0.4905 | 0.1076   |
| FBXO6        | -0.8528 | -0.1235  | -0.3585  | 0.0339   | 0.000294 | -0.2222  | -0.1767  | 0.4374   | -0.02667 | 0.5052   | 0.4676   | -0.2411 | 1.0058   |
| MCHR2        | -0.8511 | 0.4471   | -0.08868 | 0.9764   | 0.4771   | -0.00187 | 0.2073   | 2.0347   | -0.00763 | 1.8407   | 0.9236   | 2.4321  | 1.2766   |
| CD96         | -0.85   | 0.6803   | -0.3903  | -0.3242  | 0.02303  | 0.05978  | -0.4524  | 0.4848   | -0.06924 | 0.9372   | 0.8079   | 0.639   | 1.2414   |
| SFTPC        | -0.8491 | -0.3074  | -0.2772  | -0.1119  | -0.6217  | -0.9788  | -0.3327  | 0.2681   | -0.3141  | -0.00334 | 0.5776   | 0.3183  | -0.1779  |
| SPINLW1      | -0.8415 | -0.646   | 0.1217   | -0.2552  | -0.2756  | -0.5045  | -0.3354  | 0.7513   | -0.5779  | 0.4631   | 0.3808   | 0.3059  | 0.3721   |
| TRIM48       | -0.8385 | -0.6645  | 0.115    | -0.3932  | -0.5146  | -0.8034  | -0.6287  | 0.00165  | -0.7607  | 0.4474   | 0.7062   | 0.4628  | 0.7384   |
| NPAS1        | -0.8378 | 0.4595   | 0.3854   | -0.7251  | -0.1157  | -0.6619  | -0.3072  | 0.4893   | -0.2095  | 0.7522   | 1.0586   | 1.0493  | 0.8266   |
| ZFP36L1      | -0.8309 | -0.8543  | -0.2925  | -0.1191  | -0.0232  | -1.6129  | -0.1969  | 1.2232   | 0.191    | 1.1808   | -0.394   | 0.377   | 0.4443   |
| NROB2        | -0.8301 | -0.5187  | -0.04752 | -0.532   | -0.5275  | -0.15    | -0.07455 | 0.6326   | 0.009165 | 0.001066 | 0.06323  | 0.03737 | -0.09023 |
| SERPINA1     | -0.8272 | -0.07759 | -0.08938 | -0.808   | -0.5866  | -0.2711  | -0.6929  | 0.5675   | 0.04003  | 0.6071   | 0.2934   | 0.6472  | -0.6447  |
| TNFSF10      | -0.8271 | -0.4761  | -0.3359  | -0.3221  | -0.2967  | -0.6989  | -1.7703  | -0.3964  | 0.09304  | -0.0721  | 0.8621   | 0.2006  | 1.1676   |
| MAPK1        | -0.8271 | 0.2957   | 0.4764   | -0.3963  | 0.0319   | -0.6777  | -0.3924  | 0.6683   | 0.08021  | 0.323    | 0.6165   | 0.4257  | 0.9337   |
| GREB1L       | -0.8267 | -0.0631  | 0.5698   | -0.4844  | 0.4833   | 1.5111   | 0.6688   | 1.8568   | 0.1755   | 2.3575   | 1.5959   | 1.8541  | 1.9928   |
| EIF2AK3      | -0.8252 | -0.1693  | 0.4099   | -0.02194 | 0.181    | -0.6604  | 0.3973   | 0.7494   | 0.6791   | 0.4575   | 0.3425   | 0.2517  | 0.8571   |
| HIST1H2BB    | -0.824  | -0.2336  | -0.07626 | 0.393    | 0.2101   | 0.8133   | -0.01456 | 0.8093   | 0.6072   | 0.2724   | 0.721    | 0.8731  | 0.7522   |
| AOC3         | -0.8232 | -0.2178  | 0.4183   | -0.223   | -0.2829  | 0.1709   | -0.1727  | 0.9788   | 0.6502   | 0.4628   | -0.00771 | 0.525   | 0.1873   |
| SEMA6C       | -0.8215 | -0.6184  | -0.4292  | -0.03661 | -0.4662  | -1.0916  | -1.0373  | 0.0998   | 0.1788   | -0.1338  | -0.1047  | -0.5272 | 0.00134  |
| MTMR1        | -0.8177 | 0.03109  | 0.4881   | -0.7201  | 0.07635  | 0.196    | -0.02363 | 0.7305   | 0.3341   | 1.3176   | 0.9648   | 0.4734  | 0.2256   |
| MEIS3        | -0.817  | 0.6103   | -0.2918  | -0.4452  | -0.9202  | -0.935   | -0.4347  | 0.496    | -0.3273  | 1.3123   | 0.3703   | 0.3594  | 0.7955   |
| ATP13A1      | -0.8169 | -0.3722  | 0.7077   | -0.2975  | 0.3809   | -0.4446  | 0.07891  | 1.595    | 0.3853   | 0.03582  | 0.8563   | 1.264   | 0.9832   |
| ZNF667       | -0.8163 | -0.5669  | -0.3152  | -0.2656  | 0.1935   | 0.04869  | 0.6083   | 0.3189   | 1.4979   | 0.1534   | 0.4417   | 0.8411  | 0.9323   |
| KCNA2        | -0.8158 | -0.8856  | 0.192    | 0.1051   | -0.4536  | 0.05396  | -0.2794  | 0.5423   | -0.00251 | 1.0233   | 0.07021  | 0.3052  | 0.854    |
| FCGR2A       | -0.8137 | 0.2664   | -0.06291 | -0.7719  | 0.1162   | -0.1344  | -0.1457  | 0.7351   | -0.03471 | 0.2173   | 0.5368   | 0.3152  | 0.7191   |
| RXFP1        | -0.8111 | -0.1303  | 0.07008  | -0.7411  | -0.3668  | -0.4168  | -0.605   | 0.6878   | 0.3117   | 0.09258  | -0.2849  | 0.5394  | -0.1851  |
| RBX1         | -0.81   | -0.03504 | -0.9034  | -1.5061  | -0.3055  | -1.9027  | -0.4719  | -0.06234 | 0.3546   | 0.347    | -0.5576  | -0.1061 | 0.08901  |
| OR6K6        | -0.8084 | 0.2096   | 0.4571   | -0.7956  | -0.1073  | 0.1746   | -0.01709 | 0.4232   | 0.4206   | 0.8241   | 0.9534   | 0.5853  | 0.1837   |
| PTPN13       | -0.8081 | -0.2327  | 0.08911  | -0.3034  | 0.2963   | -0.9147  | -0.8882  | -0.1954  | 0.353    | 0.7709   | 0.5203   | 1.7633  | 0.3997   |
| HNRNPA3      | -0.8081 | -0.4187  | -0.6985  | -0.5857  | -0.629   | -0.3979  | -0.8757  | 0.04506  | -0.3928  | 0.3376   | 0.7688   | -0.4578 | -0.5273  |
| GMIP         | -0.8075 | -0.3292  | 0.3236   | -0.446   | -0.04613 | -1.3891  | -0.5517  | -0.1235  | 0.3901   | 0.411    | 0.0595   | 1.085   | 0.5717   |
| MEP1B        | -0.8073 | -0.8672  | 1.0546   | 0.8249   | -0.7719  | 0.1929   | -0.5837  | 1.9838   | 0.9574   | 1.4898   | 0.5062   | 1.0949  | 0.5895   |
| SERPINA4     | -0.8066 | 0.2215   | -0.38    | -0.6871  | -0.7659  | -1.9394  | -1.1798  | -0.3344  | 0.2946   | 0.03144  | 0.7585   | 0.629   | -0.3173  |
| ADAM28       | -0.8064 | -0.288   | -0.4152  | -0.606   | -0.09108 | 0.01098  | -0.2492  | 0.1611   | -0.2003  | 0.1563   | 0.5446   | 0.53    | -0.1813  |
| SCUBE3       | -0.8055 | -0.9994  | 0.03669  | -1.1219  | 0.07588  | -0.9101  | -1.3397  | -0.6068  | 0.03561  | -0.1156  | 0.6062   | 0.7707  | 0.5554   |
| ACRBP        | -0.8044 | -0.0582  | 0.2859   | -0.4842  | -0.1059  | -0.4611  | 0.7446   | 0.4131   | 0.6826   | 0.3446   | 0.679    | 0.3068  | 0.5559   |
| MAT2A        | -0.8032 | 0.6849   | -1.5058  | -0.9635  | -0.5157  | -0.5267  | -0.7563  | 1.1054   | 0.1308   | -0.485   | 0.4847   | 0.8685  | 0.53     |
| LOC100507699 | -0.8027 | -0.218   | 0.1861   | -0.03755 | 0.07031  | -0.4069  | -0.04468 | 0.6771   | 0.3499   | 0.7556   | 0.1343   | 0.1842  | -0.02956 |
| PHF13        | -0.8022 | -0.3746  | 0.3934   | -0.5886  | 0.06008  | -0.5024  | -0.9374  | 0.4182   | 0.2075   | 0.4319   | 0.3843   | 0.1967  | -0.1769  |

|         |         |          |          |          |          |          |          |          |          |         |          |         |         |
|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|---------|---------|
| RNASE4  | -0.8019 | -0.42    | -0.175   | -0.259   | 0.4883   | -1.9309  | -0.605   | 0.2154   | 0.2175   | 0.956   | 0.4188   | 0.3397  | 0.1982  |
| IL17A   | -0.7991 | -0.2979  | -0.1347  | -0.3431  | -0.08196 | 0.1521   | 0.07993  | -0.1343  | 0.7399   | 0.3983  | 0.5951   | 0.07509 | 0.2171  |
| WWOX    | -0.798  | -0.5683  | 0.01756  | -0.1394  | -0.2857  | -0.5461  | -0.3527  | -0.3394  | -0.02074 | 0.9444  | 0.7615   | 0.5834  | -0.153  |
| ZNF514  | -0.7958 | 0.392    | -0.475   | 0.0793   | -0.5133  | -0.4247  | -0.477   | 0.3971   | 0.8198   | 0.03949 | 1.7009   | 0.8667  | -0.1867 |
| GALC    | -0.7956 | -0.04795 | -0.2773  | 0.1019   | 0.1521   | -0.393   | -0.3138  | 0.6396   | -0.2394  | 0.6285  | -0.1171  | 0.9268  | 0.998   |
| HIPK1   | -0.7923 | -0.5385  | -0.3516  | -0.4366  | -0.3476  | -0.9417  | -0.6933  | 0.05442  | 0.5049   | -0.5795 | 0.186    | -0.4584 | 0.01389 |
| PPP1R10 | -0.7916 | -0.2073  | 0.1453   | -1.3836  | 0.3754   | -0.2515  | -0.3267  | 0.3264   | 0.3418   | 0.5719  | 0.9991   | 0.4406  | 2.4581  |
| TRIM43B | -0.7894 | 0.3497   | 0.4016   | 0.1903   | 0.5681   | 0.7713   | 0.6028   | 1.9996   | 0.5237   | 1.3372  | 0.349    | 1.574   | 1.0607  |
| TRIM43  | -0.7894 | 0.3497   | 0.4016   | 0.1903   | 0.5681   | 0.7713   | 0.6028   | 1.9996   | 0.5237   | 1.3372  | 0.349    | 1.574   | 1.0607  |
| CYP3A4  | -0.789  | -0.1025  | -0.6091  | -0.4519  | -0.5767  | -0.1106  | -1.0082  | 0.1866   | -0.4191  | 0.3597  | 0.3949   | 0.09045 | -0.2712 |
| FZD3    | -0.7881 | 0.03929  | 1.1884   | -0.6744  | 0.1079   | -0.2541  | 0.4294   | 0.5293   | 0.6267   | 1.1961  | 0.7368   | 1.4326  | 0.9715  |
| OR1E1   | -0.7876 | -0.5541  | -0.09466 | -0.1528  | -0.1337  | -0.9431  | -0.4856  | -0.06117 | 0.2016   | 0.413   | 0.1737   | -0.1985 | -0.1763 |
| ARFGAP3 | -0.7871 | -0.3315  | -0.1882  | 0.2396   | 0.4154   | -0.05411 | -0.3803  | 1.4889   | -0.5883  | 0.9017  | 1.3896   | 1.028   | 0.5631  |
| NLRP12  | -0.7869 | -0.3979  | 0.1818   | -1.2903  | 0.1914   | 0.08227  | -0.2898  | 0.9768   | -0.2288  | 0.6656  | 0.198    | 1.2105  | 0.8471  |
| IL22    | -0.7865 | -0.00887 | 0.06363  | -0.06503 | 0.04497  | -0.05387 | 0.3225   | 0.6968   | -0.1764  | 0.4568  | 1.1758   | 0.842   | 0.2311  |
| STRADA  | -0.7852 | -0.05178 | -0.2982  | 0.4264   | -0.7012  | 0.07194  | -0.817   | 0.2516   | 0.5238   | 0.5132  | 0.6825   | -0.1843 | 0.5661  |
| TRIM43B | -0.7823 | 0.2375   | 0.07888  | -0.8607  | -0.1465  | 0.5308   | -0.3815  | 0.117    | 0.4312   | 0.5051  | 0.4423   | 1.0803  | 0.6946  |
| TRIM43  | -0.7823 | 0.2375   | 0.07888  | -0.8607  | -0.1465  | 0.5308   | -0.3815  | 0.117    | 0.4312   | 0.5051  | 0.4423   | 1.0803  | 0.6946  |
| PROCR   | -0.782  | -0.7951  | 0.6577   | -1.2318  | -0.3118  | -0.7275  | 0.1641   | 0.3075   | 0.3193   | 0.2524  | 0.3836   | 0.3919  | 1.3877  |
| ZNF438  | -0.782  | -0.5827  | 0.01924  | -0.546   | -0.3966  | 0.5258   | -0.2145  | 0.2857   | 0.35     | 0.6896  | 1.0421   | 0.1205  | 0.05127 |
| TRAM1   | -0.7792 | -0.7846  | 0.4001   | -0.09629 | -0.7224  | -0.5594  | -0.0773  | 0.09569  | 0.2183   | 0.688   | -0.00707 | 0.5321  | 0.08736 |
| ACMSD   | -0.7771 | -0.7134  | -0.6828  | -1.1437  | -0.5845  | -0.4228  | 0.104    | 0.3743   | 0.1965   | 0.3199  | -0.306   | -0.536  | 0.1285  |
| DLK1    | -0.7766 | -0.7459  | -1.1271  | -0.5224  | -0.08735 | -1.266   | -1.5451  | 0.0381   | -0.2826  | -0.171  | -0.2306  | -0.2808 | -0.7198 |
| CPPED1  | -0.7765 | -0.1924  | 0.2097   | -0.6477  | -1.229   | -0.2981  | -0.9251  | 0.5784   | 0.2243   | 0.2298  | -0.09949 | 1.4738  | -0.2088 |
| LYN     | -0.7753 | -0.09631 | -0.332   | -1.0551  | -0.6274  | -0.5901  | -0.04642 | -0.08816 | -0.04845 | 0.1708  | -0.08333 | 0.3598  | -0.2642 |
| WDSUB1  | -0.7751 | -0.02813 | 0.07899  | -0.4192  | -0.09337 | 0.1355   | 0.06323  | 0.003635 | 0.3797   | 0.2459  | 0.3092   | 0.5728  | 0.1026  |
| PRKAR1A | -0.7737 | 0.4395   | -0.7594  | 0.03463  | -0.5301  | 0.2672   | -0.1644  | 0.317    | 0.2395   | 0.4177  | 0.141    | 0.4565  | 0.5064  |
| NUP107  | -0.7733 | -0.03245 | 0.000844 | -0.1364  | -0.9884  | 0.07464  | -0.01884 | 0.2385   | 0.5395   | 0.1034  | 0.222    | 0.07063 | 0.4769  |
| DLG2    | -0.7731 | -0.6963  | 0.5742   | 0.5685   | -0.6467  | 1.4336   | -0.06266 | 1.2469   | 0.0225   | 1.4925  | 2.0188   | 1.9302  | 1.6615  |
| ZNF37A  | -0.7728 | -0.575   | -0.2602  | -0.2143  | 0.04508  | -0.2227  | -0.4367  | -0.4194  | 0.3437   | 0.04782 | 0.2214   | 0.09927 | 0.3674  |
| TAF1B   | -0.7727 | 0.2018   | -0.02364 | -0.6243  | -0.3038  | -0.2141  | -0.6363  | 0.01953  | 0.3617   | -0.1807 | 0.356    | 0.2051  | 0.1371  |
| HDAC3   | -0.7713 | 0.4612   | -0.3734  | -0.373   | 0.8408   | 0.6288   | 0.0714   | 1.2863   | 0.7619   | 0.6974  | 0.5865   | 0.581   | 1.029   |
| NACAP1  | -0.7709 | -0.1639  | -1.0048  | -0.2532  | 0.1536   | -1.1288  | -0.8173  | 0.7449   | 0.0728   | -0.2845 | 0.09546  | 0.7175  | -0.1483 |
| TNRC6C  | -0.7709 | -0.00917 | 0.3813   | 0.3582   | -0.1601  | 0.3523   | 0.2385   | 0.2277   | 0.3702   | 0.44    | 0.717    | 1.0132  | 1.1346  |
| PIK3R6  | -0.7707 | -0.3449  | -0.6182  | -0.604   | -0.5968  | -1.4274  | 0.9253   | 0.2068   | 0.2486   | 0.6989  | 0.1573   | 0.4601  | 0.1265  |
| TRAIP   | -0.7699 | 0.4046   | -1.0006  | -0.1762  | -1.5337  | -0.368   | 0.309    | 0.5018   | 0.3346   | 0.399   | 0.2561   | 0.04054 | 0.8675  |
| CARD9   | -0.7635 | -0.1266  | 1.0018   | -0.1195  | 0.5587   | 0.1103   | 0.1627   | 1.1871   | -0.1337  | 1.2788  | 0.943    | 1.7525  | 1.8564  |
| SFXN2   | -0.7633 | -0.1418  | -0.01711 | 0.4642   | 0.1151   | -0.1228  | -0.6329  | 1.0983   | -0.4177  | 0.07596 | 1.3686   | 1.2874  | 1.8072  |
| TWF2    | -0.763  | -0.5791  | 1.523    | 0.6148   | 0.07051  | 1.7073   | 1.0307   | 1.7666   | 0.7453   | 2.2864  | 1.7151   | 2.323   | 2.4285  |

|             |         |          |          |          |          |          |          |         |          |          |          |          |          |
|-------------|---------|----------|----------|----------|----------|----------|----------|---------|----------|----------|----------|----------|----------|
| ANK3        | -0.7612 | 0.147    | -0.0252  | 0.4041   | 0.1108   | 0.118    | 0.221    | 0.3823  | 0.4509   | 0.4516   | 1.1876   | 0.469    | 0.2219   |
| DNAJB6      | -0.7606 | -0.4021  | 0.7037   | -0.6762  | -0.317   | 0.06286  | -0.3617  | 0.628   | -0.4317  | 1.2285   | 1.0923   | 0.4128   | 1.3189   |
| HLA-DRB5    | -0.7605 | -0.05808 | -0.03369 | 0.2098   | 0.5409   | 0.729    | -0.2872  | 0.2304  | 0.5383   | 0.7833   | 0.7953   | 0.846    | 0.7494   |
| FXYP6-FXYP2 | -0.7591 | -0.2707  | 0.3198   | -0.557   | 0.04634  | 0.01439  | 0.1389   | 0.2871  | -0.1768  | 0.7342   | 0.5306   | 1.7334   | 0.967    |
| SSH3        | -0.7591 | -0.2723  | -0.00759 | -1.1432  | -1.1139  | -1.2911  | 0.1189   | 0.7066  | 0.01864  | -0.03439 | 0.4924   | -0.3043  | 0.008941 |
| IDH2        | -0.7563 | -0.1658  | 1.0469   | 0.8507   | -0.7953  | -1.0087  | -0.2282  | 1.4639  | 0.3926   | 0.8758   | 0.4196   | 1.0655   | 1.4348   |
| UCK1        | -0.7551 | -0.7091  | -0.1339  | -0.7448  | -0.7271  | -0.9141  | -0.08114 | 0.2903  | -0.4699  | 0.2325   | -0.5945  | 0.5242   | 0.7103   |
| TET1        | -0.7551 | 0.3818   | -0.3465  | 0.1898   | 0.4028   | -0.8526  | 0.2336   | 0.67    | 0.9015   | -0.02177 | 1.0481   | 0.8602   | 0.5408   |
| OSGEPL1     | -0.7546 | -0.4703  | 0.0511   | 0.3942   | -0.06806 | 0.616    | -0.7721  | 0.4751  | 0.3518   | 0.3376   | 0.8959   | 0.3691   | 0.7212   |
| SLC7A11     | -0.7545 | -0.602   | 0.04772  | 0.1118   | 0.5016   | 0.08221  | -0.1817  | 0.8106  | 1.0825   | 0.993    | -0.07021 | 0.3207   | 0.4763   |
| FGF9        | -0.7537 | -0.1333  | -0.1514  | 0.09698  | 0.06528  | -0.3318  | 0.01698  | 0.1139  | 0.5634   | 0.02569  | 0.06747  | 0.7717   | 0.1525   |
| CLCA4       | -0.7533 | 0.6746   | 0.6096   | -0.07055 | -0.1459  | 0.5096   | -0.00786 | 1.0223  | 1.275    | 0.4631   | 0.5011   | 0.8235   | 0.6206   |
| ZNF780B     | -0.7526 | 0.2645   | 0.06325  | 0.3777   | -0.4756  | -0.5864  | -0.1609  | 0.576   | -0.2367  | 0.616    | 0.7768   | 1.4677   | 0.5172   |
| CES1P1      | -0.751  | -0.5413  | 0.2757   | 0.1896   | -0.03907 | -0.5168  | -0.4315  | 0.374   | 0.2983   | 0.5229   | 0.1328   | -0.1319  | 0.5963   |
| GRIA1       | -0.7506 | 0.2549   | 1.0687   | -0.4357  | 0.444    | -0.9524  | -0.5429  | 0.8893  | 0.502    | 0.4585   | 0.7842   | 0.5643   | 0.9522   |
| HIST1H2BH   | -0.7502 | -0.07471 | 0.8579   | 0.03224  | 0.2936   | 0.3418   | 0.6058   | 1.4592  | -0.4284  | 1.51     | 1.0211   | 2.3625   | 2.3377   |
| SLCO4A1     | -0.7493 | 0.5921   | 0.6258   | 0.6422   | -0.5314  | 0.5028   | 0.03642  | 2.0082  | -0.4394  | 0.9658   | 1.6537   | 2.0521   | 2.7222   |
| SKIV2L2     | -0.7492 | -0.8435  | -0.01833 | -1.1056  | -0.02204 | -2.0078  | -1.1642  | -0.1752 | 0.5942   | -0.8965  | 0.3935   | 1.1819   | 0.3382   |
| GNAT2       | -0.7487 | -0.3539  | -0.1171  | -0.3435  | -0.3624  | 0.07771  | 0.04297  | 0.4359  | 0.2457   | -0.2278  | -0.06228 | 1.2687   | 0.6039   |
| ZCCHC14     | -0.7487 | 0.0165   | -0.3253  | 0.3276   | -0.5227  | -0.4638  | -0.5707  | 0.687   | 0.2807   | -0.149   | 0.1826   | 0.1372   | 0.1459   |
| SP110       | -0.7481 | -0.08749 | -0.7156  | 0.3002   | 0.6329   | 0.07079  | 0.187    | 0.857   | 0.3543   | 0.925    | 0.7087   | 0.833    | 0.1502   |
| MYO3B       | -0.7481 | -0.1129  | 0.1105   | 0.7424   | -0.5722  | 0.06312  | -0.2451  | 0.01668 | 0.4502   | 1.04     | 0.8153   | 0.7223   | 2.1497   |
| BBS7        | -0.747  | -0.4513  | 0.4305   | 0.02221  | -0.5839  | -0.1392  | 0.1151   | 0.7546  | 0.0227   | 0.39     | 1.336    | 0.2599   | 2.6319   |
| PMF1        | -0.7466 | -0.5184  | -0.5137  | -0.3352  | -0.8296  | -1.029   | -0.848   | -0.3748 | 0.149    | -0.07664 | 0.4245   | -0.6766  | -0.4837  |
| BIRC8       | -0.7463 | 0.004563 | 0.675    | 0.6513   | 0.5669   | 0.3379   | 1        | 1.4083  | 0.7551   | 0.5949   | 1.2826   | 0.9286   | 1.2198   |
| CDHR5       | -0.7458 | 0.4218   | 0.1199   | -0.05415 | -0.666   | -0.01045 | 0.5293   | 0.5403  | 1.2068   | 0.679    | 1.3112   | 0.4683   | 0.1006   |
| ZNF222      | -0.7441 | -0.6674  | 1.2231   | -0.8812  | -1.0655  | -1.1013  | -0.3688  | 0.5837  | 0.4418   | 1.7143   | -0.01053 | 0.749    | 0.2418   |
| ZNF611      | -0.7433 | 0.2734   | 0.06374  | -0.2973  | -0.1746  | -0.29    | -0.3704  | -0.3915 | 0.9475   | 1.0008   | 0.06968  | 0.3358   | 0.8824   |
| DCX         | -0.7432 | -0.4711  | 0.6097   | -0.1074  | -0.6309  | -0.4577  | -0.7314  | 0.6078  | -0.08352 | 0.554    | 0.1554   | -0.00143 | 0.5885   |
| RMND5A      | -0.7429 | 0.6679   | -0.3791  | -0.8841  | 0.5774   | -0.2125  | -1.7411  | 0.1436  | 0.94     | 0.4252   | 1.2118   | 0.6861   | 0.4147   |
| LEP         | -0.7422 | -0.2017  | 0.3811   | -0.2338  | -0.4021  | -0.2573  | -0.05463 | 0.2711  | -0.2809  | 0.4483   | 0.3103   | 0.552    | 0.9782   |
| BIK         | -0.7401 | -0.2951  | -0.8794  | -0.1656  | -0.5828  | 0.3389   | -0.3078  | 1.0231  | 0.192    | 0.01761  | 0.1366   | 0.2978   | -0.02604 |
| N6AMT1      | -0.7351 | -0.1894  | -0.2859  | -0.6159  | -0.1826  | 0.2094   | 0.6521   | 0.2661  | 0.6804   | 0.6021   | 0.4053   | 0.07955  | 0.4711   |
| NKX2-1      | -0.7344 | -0.6128  | 0.6248   | 0.7551   | -0.1299  | -0.1905  | -0.3899  | 1.043   | 0.6864   | 0.826    | 0.912    | -0.1135  | 1.5685   |
| METTL4      | -0.7331 | -0.2964  | -0.8327  | -0.3446  | -0.1683  | -0.3463  | -0.4592  | 0.7112  | 0.4006   | 0.336    | 0.2263   | -0.3549  | -0.5914  |
| CIB3        | -0.7329 | -1.1948  | -0.1199  | 0.1787   | 0.07303  | -1.5346  | -0.6944  | -0.1078 | 0.4753   | 0.01337  | 0.02058  | 0.7384   | 0.1202   |
| ROBO1       | -0.7327 | 0.3446   | 0.04219  | -0.8188  | 0.06888  | -0.2108  | -0.1533  | 0.2775  | 0.4568   | 0.1483   | 0.7934   | 0.6514   | 0.003881 |
| WFDC12      | -0.732  | -0.2567  | 0.05207  | -0.1514  | -0.05732 | -0.7397  | -0.4702  | -0.174  | 0.238    | 0.4133   | -0.3088  | 0.6888   | 0.5664   |
| CHN2        | -0.731  | 0.01007  | -0.6391  | 0.09309  | 0.2739   | 0.09182  | -0.3929  | 0.4053  | 0.1339   | 0.1413   | 0.3401   | 0.8121   | 0.2357   |

|          |         |          |          |          |          |          |          |          |          |         |          |          |          |
|----------|---------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|----------|----------|
| LAMA2    | -0.7307 | -0.2928  | -0.9599  | -0.518   | 0.01974  | -0.05017 | -1.0554  | 0.1116   | 0.4007   | 0.4417  | 0.7121   | 0.8709   | -0.797   |
| ZNF585B  | -0.7301 | 0.1035   | 1.0518   | -0.9311  | 0.3813   | 0.1016   | 0.07387  | 2.2053   | 0.0432   | 0.3459  | 1.7403   | 2.1763   | 1.1312   |
| PFDN1    | -0.7295 | 0.5906   | 0.5289   | -1.1064  | 0.003316 | -1.0055  | -0.1659  | 1.0237   | -0.333   | 2.0367  | 1.3126   | 1.0588   | 0.4548   |
| ACVR2B   | -0.7283 | -0.1568  | 0.1802   | 0.147    | 0.07144  | -1.6285  | -0.8757  | 0.7713   | -0.01444 | 0.4984  | 0.3892   | 0.2751   | 0.1834   |
| MAP3K1   | -0.7277 | 0.519    | -0.3994  | 0.05261  | -0.03456 | 0.2393   | 0.3448   | 0.6635   | 1.0698   | 0.2914  | 0.6509   | 0.4672   | 0.2808   |
| LONRF3   | -0.7275 | -0.7967  | 0.3397   | -0.08385 | -0.1645  | -0.3709  | -0.4131  | 0.1913   | 0.6117   | 0.08059 | 0.6041   | 0.06671  | -0.09167 |
| MS4A1    | -0.7273 | 0.5977   | 1.1651   | -0.172   | -0.03192 | 0.2728   | -0.3067  | 0.7905   | 0.8398   | 1.0917  | 0.4576   | 1.9052   | 0.9809   |
| ITGA3    | -0.7267 | 0.5422   | -0.2783  | 0.06693  | 0.02953  | 0.177    | -0.1337  | 0.5513   | 0.3849   | 0.3439  | 0.6581   | 0.574    | 0.06236  |
| HLA-DQB2 | -0.7262 | 0.1854   | 0.02301  | -0.1463  | 0.178    | 1.121    | 0.928    | 1.5475   | 0.7299   | 1.3762  | 2.2972   | 0.5976   | 0.807    |
| GPR148   | -0.7255 | 0.03194  | 0.652    | 0.4565   | 0.0228   | 0.673    | 0.2903   | 0.7315   | 0.4394   | 1.6751  | 0.601    | 0.6899   | 1.4053   |
| MKX      | -0.7252 | -0.6518  | -0.3048  | 0.4386   | -0.2612  | -0.1677  | -1.0183  | 0.1877   | -0.3574  | 0.3149  | 0.4595   | 0.4283   | 0.6396   |
| PCDHA13  | -0.7249 | -0.3109  | 0.4599   | -0.5826  | 0.1699   | -0.4818  | -0.271   | 0.6693   | 0.03808  | 0.4109  | 1.0928   | 1.1532   | -0.2174  |
| ACADS    | -0.7215 | 0.3692   | -0.5653  | -0.827   | -0.2668  | -0.2021  | -0.3114  | -0.01702 | 0.2599   | 0.1303  | -0.08095 | 0.3684   | 0.02365  |
| ZNF182   | -0.7199 | -0.2524  | -0.4425  | 0.1535   | -0.3753  | -0.2775  | 0.03095  | -0.1607  | 0.4391   | 0.1811  | -0.01789 | 0.08466  | 0.2214   |
| AMY2A    | -0.7196 | -0.5503  | 0.389    | 0.922    | -0.03759 | 0.04251  | -0.1868  | 1.0621   | 1.0085   | 0.5963  | 0.3495   | 0.2647   | 1.1898   |
| TBC1D9B  | -0.7193 | -1.0766  | -1.3033  | -0.0033  | 0.02789  | -0.09164 | -1.3908  | 0.3657   | -0.353   | 0.8685  | 0.1841   | -0.339   | 0.4451   |
| TSLP     | -0.7188 | -0.2055  | 0.4866   | -0.6049  | 0.2528   | -0.8182  | -0.8864  | -0.471   | 0.444    | 0.7864  | 0.8539   | 0.3894   | 0.9341   |
| PIK3CB   | -0.7181 | 0.1275   | -0.4628  | 0.2543   | -1.9786  | 0.2909   | -2.6051  | 0.7034   | 0.9789   | 0.01565 | 0.2951   | 0.1489   | 0.4458   |
| PRKAG1   | -0.718  | -0.2477  | 0.6237   | -0.2596  | 0.05823  | 0.2908   | -0.6226  | 1.7122   | 1.4745   | -0.1427 | 0.8997   | -0.08728 | 1.4031   |
| COL4A2   | -0.7151 | -0.9007  | -0.71    | -0.6197  | -0.1889  | -0.5469  | -0.6843  | -0.2957  | -0.1083  | -0.442  | -0.06945 | -0.5925  | 0.4675   |
| SLC5A12  | -0.715  | -0.4555  | 0.3657   | -0.611   | -0.5799  | -0.4136  | -0.4072  | 0.5565   | 0.7918   | 0.2153  | 0.3822   | -0.1378  | -0.4285  |
| HELLS    | -0.7137 | -0.2502  | 0.2055   | -0.232   | -0.4488  | -0.8488  | -0.02855 | 0.5881   | -0.4371  | 0.7515  | 1.2182   | 0.1762   | 0.1154   |
| ADPGK    | -0.7133 | 0.5032   | 0.4662   | -0.8753  | 0.5766   | -0.3023  | 0.4031   | 0.5815   | 0.6488   | 1.2136  | 0.5831   | 0.4988   | 0.9371   |
| SIM2     | -0.713  | -0.406   | -0.4588  | -0.2096  | -0.3774  | 0.3397   | -0.2439  | 0.1265   | 0.7557   | -0.155  | 0.03179  | 0.4216   | 0.1049   |
| BBOX1    | -0.7124 | -0.01328 | -0.2554  | 0.2018   | 0.1376   | -0.4879  | 0.4602   | 0.1581   | 0.2485   | 1.0987  | 0.07037  | 1.5587   | 0.9628   |
| EFCAB1   | -0.7121 | 0.7843   | 0.5265   | 0.7929   | -0.2189  | -0.1312  | -0.1444  | 2.5997   | 0.6056   | 0.8297  | 0.5395   | 1.7567   | 0.8358   |
| OBP2A    | -0.7115 | -0.451   | -0.5613  | 0.004512 | -0.4584  | -0.195   | -0.6056  | -0.4661  | -0.02737 | 0.3335  | -0.3217  | 0.699    | 1.0476   |
| GPR15    | -0.7112 | -0.6935  | 0.1658   | -0.6104  | 0.6559   | -0.2335  | -0.5418  | 0.1399   | 0.5966   | 0.8943  | 0.6384   | 0.5776   | -0.1811  |
| BBS4     | -0.711  | 0.2607   | -0.1244  | -0.3049  | -0.08696 | -0.5547  | 0.2662   | 0.2842   | 0.5506   | 0.08707 | 0.3021   | 0.5515   | 0.01096  |
| MATR3    | -0.7108 | -0.6252  | -0.1891  | 0.00191  | -0.1019  | -0.5936  | -0.0319  | -0.2699  | 0.7934   | 1.0693  | -0.5084  | 0.5785   | 0.6875   |
| ATP6V1B2 | -0.71   | -0.7158  | 0.2091   | -0.6122  | 0.1144   | 0.6084   | -1.377   | 0.1081   | 1.1769   | 0.1804  | 0.3162   | 0.5065   | 1.4869   |
| RAVER1   | -0.7087 | -0.3648  | -0.4734  | -0.6964  | -1.0316  | -0.5495  | 0.2295   | 0.1085   | 0.8848   | 0.867   | 0.8463   | -0.04363 | -0.8304  |
| FETUB    | -0.7082 | -0.07564 | -0.3166  | -0.07829 | -0.433   | -0.00891 | 0.5196   | 0.8606   | 0.2232   | 0.6019  | 0.316    | 0.1328   | 0.1263   |
| HAAO     | -0.7071 | -0.7533  | -0.04987 | 0.2612   | 0.112    | 1.5941   | -0.8594  | 0.6884   | 1.0894   | 0.803   | 0.428    | 1.2812   | 1.1178   |
| PKNOX2   | -0.7057 | -0.0222  | 0.01942  | -0.09454 | -0.8592  | -0.2486  | -0.1026  | -0.04622 | -0.1567  | 0.4883  | 0.3518   | 0.6445   | 0.1225   |
| FGR      | -0.7053 | -0.536   | 0.1497   | 1.1881   | 0.1708   | 2.5293   | 0.8181   | 2.4153   | 1.029    | 1.7319  | 1.8668   | 2.8511   | 1.639    |
| BCL9     | -0.7049 | -0.4312  | -1.2011  | -1.0181  | 0.07526  | -0.7101  | -0.00985 | 0.6573   | 0.6968   | -0.1113 | 0.07642  | -0.113   | -0.3996  |
| SIRPG    | -0.7044 | -0.2269  | 0.9907   | -0.2857  | -0.5336  | -0.3412  | -0.9057  | 0.3376   | 0.3149   | 0.2872  | 0.6672   | 0.5202   | 0.1061   |
| ZNF524   | -0.7026 | -0.00018 | -0.4188  | -0.734   | 0.03538  | -0.2626  | -0.1174  | -0.2243  | -0.7524  | 1.401   | 0.4651   | 1.2801   | 1.744    |



|          |         |          |          |          |          |          |          |          |          |          |          |          |          |
|----------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| MAT1A    | -0.7025 | -1.836   | -0.8944  | -1.2442  | 0.1242   | -1.0973  | -1.2559  | -0.415   | 0.2384   | -0.212   | -0.8783  | -0.3494  | -0.3404  |
| ROBO3    | -0.7016 | -0.7009  | 1.3943   | 0.6346   | -0.9833  | -0.6944  | -0.8175  | 0.4576   | 1.0973   | 0.3078   | 1.3906   | 0.7018   | 0.6735   |
| SELPLG   | -0.6998 | -0.8105  | -0.471   | -0.5645  | 0.04155  | 0.148    | -0.266   | 0.087    | -0.1359  | 0.3363   | 0.7536   | -0.04546 | 0.007277 |
| POLR2H   | -0.699  | 0.7371   | -0.8991  | -0.3292  | -0.4089  | -0.7409  | -0.515   | 0.2869   | 0.3957   | 0.04081  | 0.3503   | -0.1963  | 0.7728   |
| PRSS42   | -0.6971 | -0.8563  | 0.3077   | -0.4511  | 0.1755   | 0.1589   | -0.2773  | 0.2526   | 0.474    | 0.145    | 0.6219   | 0.9836   | -0.01831 |
| C12orf52 | -0.6966 | -0.4131  | 0.1181   | -0.5759  | -0.2754  | -1.2441  | -0.6845  | -0.00174 | 0.5468   | -0.1142  | -0.2427  | -0.153   | -0.03517 |
| DLX6     | -0.696  | -0.2328  | -0.2023  | -0.3828  | 0.1799   | -0.01663 | -0.1257  | -0.04952 | -0.1607  | 0.2361   | 0.2739   | 0.2219   | 0.4602   |
| GUCY1A2  | -0.6945 | 0.6386   | -0.06971 | -0.2133  | 0.178    | 0.9024   | 0.251    | 1.5871   | -0.05303 | 1.4037   | 1.1475   | 1.8492   | 0.5031   |
| RIPK1    | -0.6939 | -0.08299 | 0.2814   | 0.6494   | -0.01972 | 0.04099  | 0.3162   | 0.427    | 0.9518   | 0.6168   | 0.08115  | 1.2358   | 0.6883   |
| E2F1     | -0.6932 | 0.4733   | 0.212    | 0.7893   | 0.7928   | 0.5317   | -0.00717 | 1.758    | 0.2736   | 1.9519   | 0.9692   | 0.411    | 2.6404   |
| KRT24    | -0.6932 | -0.1792  | 0.8259   | 1.1076   | 0.98     | 0.02878  | 0.6983   | 1.8462   | -0.02125 | 2.1137   | 1.7598   | 1.1763   | 2.3897   |
| DDX5     | -0.6912 | 0.1156   | 0.9823   | -1.8101  | -0.1672  | -1.0354  | 1.0221   | 1.3492   | 0.4556   | 0.7137   | 0.6346   | 0.8397   | 1.5827   |
| JUB      | -0.6909 | 0.1887   | 0.3871   | -0.09661 | 0.2558   | 0.5347   | 0.2489   | 1.1499   | 0.4242   | 0.6021   | 0.4164   | 1.8523   | 0.3872   |
| SLC35C2  | -0.6902 | -0.07509 | 1.0062   | -0.3132  | -1.0259  | -0.939   | -0.4101  | 0.8525   | -0.3021  | 0.7311   | 0.4271   | 1.1605   | 0.4834   |
| SOD1     | -0.6899 | 0.0219   | -0.9547  | -0.3323  | -0.303   | -0.9572  | -1.5389  | 0.9118   | 0.7396   | -0.2017  | 0.4976   | -0.4256  | -0.5746  |
| IL21R    | -0.6897 | -0.1491  | -0.09475 | -0.08267 | -0.4505  | -0.833   | -0.3098  | 0.5529   | 0.9972   | -0.5624  | -0.2692  | 0.6022   | 0.376    |
| ACOT11   | -0.689  | 0.9211   | 1.113    | -0.5884  | -0.4783  | -0.135   | 0.08893  | 1.1674   | 0.4811   | 0.5206   | 0.892    | 1.7796   | 1.0072   |
| HS2ST1   | -0.688  | -0.1886  | -0.01415 | 0.145    | 0.002125 | 0.005992 | -0.3561  | 0.0992   | 0.02651  | 1.0691   | 0.4168   | 0.4123   | -0.01995 |
| PCDHA13  | -0.687  | -0.5758  | 0.0954   | -0.5403  | -0.1887  | -0.7146  | -0.222   | -0.3773  | 0.1578   | -0.01417 | 0.154    | 0.1588   | -0.09804 |
| S100A8   | -0.6869 | 0.03068  | -0.7551  | 0.0069   | -0.9855  | -0.6343  | 0.2867   | -0.2076  | 1.2144   | 1.8366   | -0.1815  | 0.3525   | 0.3901   |
| 10-Mar   | -0.6867 | -0.2706  | 0.07514  | -0.1647  | -0.07086 | -0.3941  | -0.7434  | 1.0275   | -0.09311 | -0.2725  | 0.6313   | -0.05487 | 0.4443   |
| SLC28A2  | -0.6856 | 0.7767   | 0.2378   | -0.8189  | -0.2827  | 0.2594   | 0.1953   | 0.5072   | 0.365    | 0.3394   | 0.6802   | 0.741    | 0.737    |
| RBM26    | -0.6853 | -0.7385  | -0.9858  | -0.8479  | -0.8936  | 0.07734  | -0.7227  | -0.9133  | 0.3707   | -0.02803 | -0.09856 | -0.2707  | 0.4207   |
| ILKAP    | -0.6851 | -0.8473  | 0.7107   | -0.6423  | -0.459   | 0.8124   | 0.3266   | 0.5536   | 0.2227   | 2.08     | 0.2286   | 2.3296   | 1.2835   |
| SFTPA1   | -0.684  | 0.0299   | -0.2988  | -0.4927  | -0.7539  | -0.8717  | -0.2505  | 0.3361   | -0.2694  | 0.6009   | -0.4732  | -0.0498  | 0.2464   |
| SACM1L   | -0.6837 | -0.09723 | 0.3416   | -0.1749  | -0.4042  | -1.9907  | -0.1973  | -0.3317  | 0.9037   | 0.3177   | 0.2484   | 0.6887   | 1.2912   |
| SUGT1    | -0.6815 | 0.6926   | 0.1654   | -0.9337  | -0.3332  | -0.3364  | -1.4416  | 0.8739   | 0.5645   | -0.1706  | 0.008847 | 0.6309   | 0.7285   |
| ALKBH3   | -0.6812 | -0.9886  | -0.1663  | -0.0189  | -0.2873  | -0.1513  | -0.5218  | -0.4597  | -0.02162 | 0.2299   | 0.2277   | 1.2212   | 0.3782   |
| SULT4A1  | -0.68   | 0.07259  | 1.2055   | 1.4539   | 1.521    | 0.888    | 0.06653  | 2.1899   | 0.2118   | 2.8425   | 1.6196   | 2.4911   | 2.3935   |
| NAALAD2  | -0.6794 | -0.58    | 0.1446   | -0.1357  | -0.2899  | -0.2259  | 0.2679   | -0.1222  | 0.1134   | 0.02737  | 0.5242   | 1.5227   | 0.9505   |
| INVS     | -0.6792 | 0.2085   | 0.663    | -0.2381  | -0.2185  | -0.6055  | 0.4182   | 0.5113   | 0.7933   | 1.2722   | 0.7151   | 0.3048   | 0.1685   |
| MXD4     | -0.6787 | -0.4583  | 0.002729 | -0.1544  | 0.07013  | -0.8571  | -0.8086  | 0.5051   | -0.5876  | 0.5961   | 0.4747   | 0.3804   | -0.06535 |
| GLP2R    | -0.6785 | -0.5151  | -0.2145  | 0.3144   | -0.5506  | -1.4762  | 0.8368   | 0.6827   | -0.04285 | 0.9691   | 0.5864   | 0.1931   | 0.8097   |
| F3       | -0.6777 | 0.7027   | -0.197   | 0.2469   | 0.7908   | -0.1012  | 0.6466   | 0.7318   | 0.4092   | 1.4644   | 0.6957   | 1.1372   | 0.9003   |
| KIN      | -0.6764 | -0.04892 | 0.5566   | 0.5508   | 0.3756   | 0.7856   | 0.4502   | 1.2922   | -0.2153  | 1.8523   | 0.7494   | 1.799    | 1.5147   |
| GALNT12  | -0.6764 | 0.3734   | 0.4243   | -0.3204  | 0.1389   | 0.1033   | -0.261   | 0.6777   | -0.1786  | 0.3949   | 0.8551   | 0.7813   | 0.7912   |
| OSCAR    | -0.675  | -0.4188  | -0.5254  | -1.1124  | -0.277   | -0.2115  | -0.8344  | 0.7293   | -0.1742  | -0.1884  | -0.916   | 0.6945   | 0.5137   |
| CAPN1    | -0.6745 | -0.6746  | 0.3578   | -0.5191  | -0.1745  | -0.2871  | 0.4525   | 1.5099   | -0.3279  | 0.8728   | 1.146    | 0.296    | 0.2447   |
| OR5M10   | -0.6735 | -0.2428  | 0.7806   | 1.0834   | 0.2143   | 0.2675   | 0.02673  | 2.3352   | 0.09811  | 1.6666   | 2.1783   | 1.3967   | 0.2681   |

|              |         |          |          |          |          |          |          |          |          |          |         |          |          |
|--------------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|----------|
| ADRA1A       | -0.672  | -0.5874  | -1.2487  | 0.3853   | 0.1324   | -0.2208  | -0.8068  | 0.6344   | -0.08019 | 0.9812   | 0.4609  | -0.2607  | 0.2298   |
| BMP6         | -0.6709 | -0.5688  | -0.5225  | 0.1094   | 0.4935   | -1.0689  | -0.4862  | 0.06364  | -0.2424  | 0.8499   | 0.6101  | 0.01757  | 0.6264   |
| CTBP2        | -0.6704 | -0.4497  | -0.4398  | -0.7429  | 0.8026   | 0.5164   | -1.6151  | 0.2444   | 0.8082   | 0.9977   | -0.1896 | 0.7177   | 0.8327   |
| TNFAIP8      | -0.67   | -0.2362  | -0.5961  | -0.551   | -0.237   | -1.0431  | -0.1502  | 0.5099   | 1.1755   | -0.3814  | 0.4166  | -0.3864  | -0.2644  |
| SIX4         | -0.668  | -0.3074  | 0.08757  | -0.716   | 0.1737   | -0.1958  | -0.1871  | 0.1386   | -0.09703 | 0.2427   | 0.03973 | 0.6139   | 0.1515   |
| SPRED1       | -0.6677 | 0.2188   | 0.3209   | -0.2017  | -0.3694  | -1.033   | 0.289    | 0.3237   | -0.02395 | 0.5068   | 1.0527  | 0.7007   | 0.2676   |
| RDH8         | -0.6675 | -0.2614  | -0.3535  | -0.8261  | -0.4838  | -0.5623  | -0.5884  | -0.3335  | -0.2328  | 0.6996   | 0.1373  | -0.5542  | -0.22    |
| LOC100507804 | -0.6674 | -0.458   | 0.02646  | -0.6773  | 0.2793   | 0.1416   | 0.05478  | 0.9603   | -0.3949  | 0.9726   | 0.4958  | 1.1034   | 0.1005   |
| APEH         | -0.6671 | -0.1802  | 0.2992   | -0.2947  | 0.467    | -0.4655  | 0.04504  | 0.5211   | 0.2101   | 0.2293   | 0.04161 | 1.128    | 1.4681   |
| PSIP1        | -0.6652 | -0.09575 | 0.5089   | -0.1368  | -1.0603  | -0.4483  | -0.5868  | 0.7438   | -1.098   | 1.3844   | 1.2716  | 0.3602   | 1.6276   |
| LEPREL2      | -0.6646 | -0.6358  | -0.507   | -1.1498  | 0.1431   | -0.3506  | -0.1209  | 0.5557   | -0.6296  | 1.2605   | 0.1036  | -0.03578 | 0.4401   |
| ZNF585A      | -0.6639 | -0.3231  | 0.6128   | -0.4442  | -0.7666  | -0.7852  | 0.7808   | 1.2732   | 0.4156   | 0.1723   | 0.511   | 0.1874   | 1.1899   |
| RBL1         | -0.6632 | 0.2354   | 0.2037   | 0.5803   | -0.437   | -1.1108  | -0.02318 | 0.8122   | 0.1258   | 0.2534   | 0.5222  | 0.6775   | 0.4698   |
| ZNF645       | -0.662  | -1.2857  | -0.9081  | -0.6576  | -0.3517  | -0.3414  | 0.1439   | -0.7758  | 0.5969   | 0.3638   | 1.4025  | -0.3036  | 0.2797   |
| NOX3         | -0.6613 | 0.3169   | -0.1028  | 0.3826   | 0.4833   | 0.02889  | -0.1211  | 0.1698   | 0.1326   | 0.6743   | 0.7073  | 0.7567   | 1.2981   |
| OR6V1        | -0.661  | 0.01847  | 0.4907   | -0.1969  | -0.4031  | -1.1534  | -0.4245  | 0.5153   | 0.5081   | 0.01502  | -0.2395 | 0.4297   | 0.6135   |
| ADORA2B      | -0.6609 | -0.5855  | -0.2672  | -0.1995  | -0.05163 | 0.2919   | 0.09496  | 0.4854   | 0.4782   | 0.3404   | -0.3416 | 0.3952   | 0.3819   |
| FSHR         | -0.6608 | -0.02934 | -0.07332 | -0.4602  | 0.5671   | -0.335   | -0.6394  | 0.3244   | -0.463   | 0.5982   | 0.2832  | 1.5957   | 1.4842   |
| HDAC2        | -0.6606 | 0.04531  | -0.4981  | -0.08724 | 0.06068  | -0.9556  | 0.3305   | 0.9096   | 0.869    | 0.4626   | 1.3518  | -0.2681  | -0.09867 |
| CAPN5        | -0.6602 | -0.8719  | 0.4141   | 0.3257   | -0.5658  | -0.7161  | 0.6366   | 0.7063   | 0.05171  | 0.3419   | 0.2886  | 1.647    | 1.2551   |
| RNF121       | -0.6587 | -0.3757  | 0.005882 | 0.1573   | 0.1449   | -0.3092  | -0.2148  | 0.2135   | 0.03887  | 0.8163   | 0.3964  | -0.1966  | 0.4503   |
| ZNF484       | -0.6586 | -0.3808  | -0.3707  | -0.9714  | -0.3833  | -0.946   | -0.2995  | 0.5318   | 0.1124   | -0.5801  | -0.4981 | -0.1312  | 0.09097  |
| NFE2L2       | -0.6574 | -0.1832  | -0.5271  | 0.004488 | -0.6856  | 0.1762   | -0.5907  | 0.002837 | -0.00749 | -0.3307  | 0.835   | 0.2916   | 0.3715   |
| METAP1       | -0.6551 | -0.6484  | -0.9095  | 0.1623   | -0.3805  | -0.3177  | -0.276   | -0.264   | 0.3436   | -0.07041 | 0.8244  | 0.6978   | -0.4337  |
| PKM2         | -0.6547 | 0.2762   | -0.4527  | -1.4945  | 0.4516   | -1.3501  | -0.2299  | 0.3726   | -0.05674 | -0.1023  | 0.6046  | 0.1859   | 0.8143   |
| LOC652797    | -0.6547 | 0.2762   | -0.4527  | -1.4945  | 0.4516   | -1.3501  | -0.2299  | 0.3726   | -0.05674 | -0.1023  | 0.6046  | 0.1859   | 0.8143   |
| NBEA         | -0.6539 | 0.1918   | 0.2492   | 0.1149   | -0.4384  | -0.1151  | -0.257   | 0.2371   | 0.5392   | -0.2289  | 0.1522  | 1.4258   | 1.2252   |
| S1PR2        | -0.6539 | -0.6796  | -0.182   | -0.0579  | -0.1087  | 0.1333   | -0.4086  | -0.3165  | -0.1892  | 0.4389   | 0.2791  | 1.1787   | 0.5635   |
| ZNF85        | -0.6533 | -0.5811  | -0.6525  | -0.1577  | -0.00018 | -0.2832  | -1.1065  | 0.3086   | 0.3878   | 0.001542 | -0.422  | -0.07935 | -0.2029  |
| NHP2L1       | -0.6533 | -1.6956  | -1.7378  | -0.971   | 0.3174   | -3.139   | 0.6687   | 0.0857   | 1.1299   | -0.05108 | -0.4502 | -0.1334  | 0.7847   |
| PCSK1        | -0.6531 | -0.5028  | -0.1573  | -0.4033  | -0.2718  | -0.1104  | 0.2373   | 0.03041  | -0.07899 | 0.4092   | 0.6217  | 0.3825   | -0.2439  |
| CUL2         | -0.653  | -0.3855  | -0.4375  | -0.8456  | -0.0458  | -0.4807  | -0.1392  | 0.1659   | -0.09267 | 0.1219   | -0.3657 | -0.1562  | -0.1331  |
| PC           | -0.6528 | -0.6592  | -0.5747  | -0.5928  | 0.1006   | -0.5732  | 0.1636   | 0.2587   | 0.4493   | 0.1391   | -0.3179 | 0.211    | -0.2254  |
| HRSP12       | -0.6527 | 0.4195   | -0.2331  | -0.00354 | -0.2047  | 0.09177  | 0.1067   | 0.3864   | 0.375    | 0.8624   | 0.08788 | 0.4914   | 0.062    |
| ZNF76        | -0.6524 | -0.2731  | 0.08326  | -0.2823  | -0.5112  | 0.3997   | 0.05484  | -0.2344  | 0.3223   | 0.6523   | 0.5812  | 0.3918   | 0.2717   |
| SLA          | -0.6521 | 0.05603  | -0.06181 | -0.00122 | -0.2648  | -0.5256  | 0.02709  | 0.5167   | 0.2716   | 0.6325   | 0.1709  | -0.04545 | -0.1917  |
| EFEMP1       | -0.6517 | 0.5193   | -0.5264  | -0.9219  | -1.136   | -0.04487 | 0.1284   | 0.276    | 0.226    | 1.111    | 1.4269  | 0.2957   | -0.3079  |
| ETV1         | -0.65   | -0.1518  | 0.01968  | -0.8066  | 0.9427   | -0.6354  | -0.4782  | 0.2864   | 1.1108   | 0.9752   | 0.1358  | 0.2118   | 0.2894   |
| TNFAIP3      | -0.6498 | 0.6566   | 0.07842  | -0.00104 | 0.7118   | -0.6243  | 0.1647   | 1.0513   | -0.3596  | 1.6694   | 1.0773  | 1.3311   | 0.8361   |

|            |         |          |          |          |          |          |          |          |          |          |          |          |          |
|------------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| LGALS3     | -0.6496 | 0.1325   | -0.2224  | 0.6108   | -0.9906  | -0.3254  | 0.6321   | 0.4866   | 1.0828   | 0.6794   | 0.5573   | 0.151    | 0.4851   |
| PAPD5      | -0.6495 | 0.2417   | -0.2498  | -0.2755  | 0.2582   | -0.8945  | -0.1754  | 0.1047   | 0.306    | 0.01717  | 0.04236  | 0.5161   | 0.8834   |
| SCG3       | -0.6489 | -0.336   | -0.4032  | -0.7392  | 0.03811  | -0.7453  | -0.399   | -0.124   | -0.1534  | 0.1004   | 0.2708   | -0.4838  | -0.06585 |
| TGFA       | -0.6486 | -0.05715 | 0.2944   | 0.06956  | 0.01232  | -0.1011  | -0.6646  | 0.08926  | 1.3524   | 0.1606   | 0.2817   | 0.2418   | 0.5012   |
| PZP        | -0.6485 | 0.1765   | 0.3442   | 0.8005   | 0.583    | -1.0369  | -0.395   | 1.521    | 0.2332   | 0.6654   | 0.6877   | 1.3254   | 0.587    |
| CD99       | -0.6481 | -0.2693  | 0.0967   | -0.04771 | 0.04628  | 0.1358   | 0.2583   | 0.5831   | -0.291   | 1.1453   | 0.4051   | 1.2554   | 0.1302   |
| RCAN1      | -0.6476 | 0.01496  | 0.1576   | -0.5616  | -0.3049  | -0.9234  | -0.09335 | 0.2966   | -0.2968  | 0.5074   | 0.3572   | -0.1694  | 0.511    |
| CLEC3A     | -0.6467 | 0.1817   | -0.375   | -0.721   | -0.8287  | -0.185   | 0.1986   | 0.3926   | 0.3353   | -0.142   | -0.04583 | 0.0674   | 0.1772   |
| TGFBR1     | -0.6465 | 0.05365  | -0.2946  | -0.6439  | -0.2779  | 0.6471   | -0.6586  | 0.5763   | 0.8176   | -0.4096  | 0.4824   | 0.3205   | 0.6012   |
| LOC440563  | -0.6457 | 0.109    | 0.2721   | -0.5952  | 0.3417   | -0.8553  | -0.4999  | -0.2812  | 0.294    | 0.4503   | 0.5196   | 0.5005   | 0.4366   |
| RSC1A1     | -0.6453 | -1.1422  | 1.2304   | 0.2612   | -0.1452  | -0.3545  | 0.2544   | 0.9697   | -0.09276 | 0.9019   | 1.0631   | 1.04     | 1.0038   |
| LDHC       | -0.6445 | 0.4847   | 0.4725   | 0.2664   | -0.4919  | 0.2579   | 0.1831   | 0.8209   | 0.3195   | 0.5131   | 0.9211   | 1.3767   | 0.2507   |
| MBOAT7     | -0.6444 | 0.6614   | 1.0666   | -0.4178  | 0.9038   | -0.8437  | 0.3792   | 1.3483   | 0.1494   | 0.8801   | 1.9255   | 1.3708   | 1.3458   |
| BCL9       | -0.6434 | -0.2178  | -0.8292  | -0.9405  | 0.6069   | -0.2634  | 0.1689   | 1.2076   | 0.4976   | 0.06152  | -0.02194 | 0.7069   | 0.1524   |
| FLG2       | -0.6431 | -0.7368  | -0.5792  | -0.4939  | -1.0981  | -0.2439  | -0.449   | -0.2061  | 0.4108   | -0.2609  | -0.3623  | -0.6261  | -0.09646 |
| PRMT8      | -0.642  | -0.3204  | -0.8756  | -0.8049  | -0.8129  | -0.289   | -0.2867  | -0.02628 | 0.000629 | -0.1001  | -0.2345  | -0.3489  | -0.6307  |
| LHX8       | -0.642  | 0.1201   | -0.2133  | 0.2499   | -0.517   | 0.5255   | -0.4445  | 0.6817   | -0.1208  | 0.9378   | 0.2038   | 0.3753   | 0.7362   |
| PON1       | -0.6419 | -0.3977  | -0.3368  | 0.158    | 0.1182   | -0.0329  | -0.1654  | -0.05732 | 0.2112   | 1.1827   | 0.3902   | -0.1643  | 0.5435   |
| THEM5      | -0.6416 | 0.02186  | -1.1953  | 0.3284   | 0.00276  | -0.9612  | 0.5426   | 0.2328   | 0.09909  | 0.7346   | 0.09033  | 1.3932   | 0.9557   |
| MAP1B      | -0.6414 | -0.2449  | 1.0562   | 0.6839   | 0.1013   | -0.3734  | 0.6524   | 0.7921   | 0.7962   | 0.9988   | 0.7955   | 0.6474   | 0.5915   |
| RNF8       | -0.6411 | -0.1638  | 0.06275  | -0.3452  | 0.09511  | 0.008259 | -0.66    | 0.09554  | 0.3044   | -0.0949  | 0.2562   | -0.03432 | 0.6842   |
| DDI2       | -0.6394 | -0.8272  | 1.0488   | 0.3724   | -0.1101  | -0.1923  | 0.2189   | 0.6214   | -0.1352  | 1.0573   | 0.9621   | 1.0972   | 1.3099   |
| RARA       | -0.6391 | -0.8121  | -0.4737  | 0.2386   | -0.2213  | -0.7952  | 0.602    | 0.5112   | -0.04713 | 0.2886   | 0.2652   | 0.1638   | 0.2411   |
| PRKCB      | -0.6385 | -0.6631  | -1.599   | 0.4028   | -0.5132  | 0.8272   | -0.7429  | 0.05912  | 0.4205   | 0.5206   | 0.376    | 0.01639  | 0.5065   |
| SLC38A2    | -0.6383 | -0.264   | -0.00314 | -0.3599  | 0.1445   | -0.6282  | 0.376    | 0.1135   | 0.01889  | 0.2619   | 0.2508   | 0.3111   | 0.9209   |
| NODAL      | -0.637  | 0.7541   | -0.4414  | 0.09987  | -0.506   | 0.0961   | 0.5635   | 0.4411   | 0.1002   | 0.9043   | 1.1065   | 0.9368   | 0.486    |
| Luciferase | -0.6367 | 0.7224   | -0.3377  | -0.1435  | 0.065    | -0.07305 | -0.09641 | 0.2627   | 0.007771 | 0.7097   | 0.566    | 0.9952   | 0.3371   |
| RASL11B    | -0.6353 | -0.9042  | -0.03822 | -1.4125  | -0.2721  | -0.1699  | 0.1286   | 0.6826   | 0.3056   | -0.5518  | 0.3537   | 0.3317   | 0.05442  |
| ABCC3      | -0.6344 | -0.1644  | -0.3468  | -1.0777  | -0.3598  | 0.1997   | -0.885   | 0.1662   | 0.7987   | -0.04054 | 0.3819   | -0.01762 | -0.4834  |
| CAMK1D     | -0.6342 | -0.7918  | 0.1047   | -0.5335  | -0.2533  | -0.2832  | -0.3467  | -0.4693  | -0.102   | 0.03593  | 0.03895  | 0.3113   | 0.4826   |
| CDX1       | -0.634  | 0.06409  | -0.2526  | 0.07772  | -0.5777  | -0.1911  | -0.3151  | 0.09899  | -0.03292 | 1.1914   | 0.09719  | 0.4519   | -0.1742  |
| LACTB      | -0.6338 | -0.2015  | -0.323   | -0.9439  | 0.3467   | 0.311    | -0.2633  | 0.4076   | 0.233    | 0.1129   | 1.0213   | 0.1429   | 0.1434   |
| GATA1      | -0.6336 | -0.1834  | 0.2218   | -0.5323  | -0.2064  | 0.3135   | 0.09131  | 0.1722   | 0.05181  | 0.6426   | -0.04901 | 1.1485   | 0.7032   |
| PRDM7      | -0.633  | -0.5364  | 0.252    | -0.3327  | 0.3955   | -0.3359  | -0.494   | 0.5386   | 0.2927   | 0.9101   | 0.06922  | -0.3537  | 0.8128   |
| CEACAM6    | -0.6328 | -0.9759  | -0.00655 | -0.2333  | -0.09985 | 0.07867  | -0.7587  | -0.04181 | 0.4958   | -0.3202  | 0.03115  | 0.5127   | 0.1994   |
| GPR39      | -0.6324 | -0.2955  | 0.4455   | -0.9856  | 0.2485   | -0.4189  | -0.2042  | 0.1205   | 0.144    | 0.6419   | 1.0125   | -0.2407  | 1.0054   |
| FAM18A     | -0.6313 | -0.4013  | -0.4303  | -0.4978  | -0.2479  | -1.1803  | -0.2814  | 0.3304   | 0.4082   | -0.4284  | -0.0138  | -0.6062  | 0.1181   |
| USP21      | -0.6309 | 0.06882  | -0.2579  | -0.344   | -0.321   | 0.09436  | -0.4016  | -0.1515  | 0.5735   | -0.1771  | 0.1494   | 0.02505  | 0.3628   |
| GLUL       | -0.6307 | -0.2661  | 0.8493   | -0.4904  | -0.5313  | -1.0603  | -0.2425  | 0.6777   | -0.2946  | 1.0132   | 0.7708   | -0.2507  | 1.0283   |

|            |         |          |          |          |          |          |          |          |          |          |         |         |          |
|------------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------|---------|----------|
| RDX        | -0.6307 | -0.1052  | -0.2164  | -0.7096  | 0.3074   | -1.0535  | -0.721   | 0.03844  | 0.2485   | 1.2232   | 1.1906  | -0.5088 | -0.1115  |
| ZFP91-CNTF | -0.6305 | 0.288    | -0.6557  | 0.03958  | -0.5978  | -0.5559  | -0.9747  | 0.5824   | -0.00939 | -0.1405  | 0.5433  | 0.1171  | -0.3455  |
| FOS        | -0.6293 | 0.7389   | -0.07687 | 0.251    | -0.6467  | -1.3078  | -1.5741  | 1.1358   | 0.4111   | 0.841    | 0.71    | 0.05124 | -0.323   |
| YKT6       | -0.6293 | -0.2837  | -0.2932  | -0.3493  | -0.2751  | 0.8005   | -0.9714  | 0.02093  | 0.9015   | 0.8241   | 0.6509  | 0.09587 | -0.06428 |
| CNTF       | -0.6288 | -0.01064 | -0.2265  | 0.1762   | -0.3674  | -0.5172  | -0.5204  | 1.1918   | -0.0985  | -0.09164 | 0.6866  | 0.2186  | -0.2202  |
| COBL       | -0.6279 | -0.5252  | 0.7212   | -0.7444  | -0.01749 | -0.2556  | 0.2524   | 0.4076   | -0.3376  | 0.7389   | 0.778   | 0.7724  | 0.7511   |
| UGT1A3     | -0.6271 | -0.6339  | 0.3761   | -0.4896  | -0.9813  | 0.1277   | 0.5108   | 0.5247   | 0.5023   | 0.7063   | -0.2957 | 0.5132  | 0.5877   |
| IDH3G      | -0.6268 | -0.4999  | 0.1911   | 0.08784  | 0.05826  | 0.7975   | 0.6737   | 0.9099   | 0.424    | 0.9692   | 0.1876  | 1.0632  | 0.8196   |
| DIS3       | -0.6262 | -0.2762  | -0.643   | -0.03139 | 0.1353   | -1.1791  | 0.1443   | 0.1518   | 0.2916   | 0.3943   | 0.7634  | -0.2595 | 0.05313  |
| ZNF354B    | -0.6258 | -0.2365  | -0.01136 | 0.4926   | 0.1749   | -0.5589  | 0.5424   | 0.95     | -0.03301 | 0.1533   | 0.4766  | 1.3454  | 1.3854   |
| PFN2       | -0.6258 | -0.8061  | 0.7164   | -0.4454  | 0.9259   | 0.9488   | 0.3173   | 1.8277   | 0.3124   | 1.348    | 0.2761  | 1.7882  | 1.5711   |
| OR1E2      | -0.625  | -0.1952  | 0.04605  | -0.3718  | 0.1566   | -0.3351  | 0.3579   | -0.02314 | 0.539    | 0.5099   | 0.3866  | 0.3313  | -0.03619 |
| KRT12      | -0.6239 | 0.1034   | -0.08672 | 1.1397   | 0.9305   | -0.1337  | -0.1808  | 0.1023   | 0.7182   | 1.3571   | 0.9179  | 1.2686  | 1.7375   |
| SEC23A     | -0.6239 | -0.2967  | 0.7068   | -1.5089  | 0.7042   | -1.0832  | -0.5347  | 0.288    | 1.2876   | 0.05922  | 0.6649  | 0.05304 | 0.909    |
| CC2D1A     | -0.6239 | -0.3853  | -0.5081  | -0.2243  | -0.4929  | -0.5866  | 0.2539   | 0.4206   | 0.3457   | 0.04873  | -0.4661 | -0.1049 | 1.5185   |
| PHLPP2     | -0.6231 | -0.3864  | 0.9942   | 0.1027   | -0.491   | 0.5312   | 0.3594   | 1.144    | 0.632    | 1.3869   | 1.651   | -0.1891 | 1.0348   |
| GYS1       | -0.623  | -0.3806  | -0.6926  | -0.4641  | -0.3012  | -0.193   | 0.3435   | 0.2266   | 0.6723   | -0.3801  | -0.1159 | 0.1194  | 0.6781   |
| MUSK       | -0.6227 | -0.6537  | -0.3255  | -0.0317  | 0.02841  | -0.7959  | -0.04333 | 0.4229   | 0.1629   | 0.3177   | -0.814  | 0.9169  | 0.7785   |
| THOC3      | -0.6203 | -1.1646  | -1.3711  | -1.2593  | -0.1744  | -1.8459  | -2.3651  | -0.2291  | -0.00366 | -0.9504  | -0.7745 | 0.3495  | -1.4042  |
| LOC728554  | -0.6203 | -1.1646  | -1.3711  | -1.2593  | -0.1744  | -1.8459  | -2.3651  | -0.2291  | -0.00366 | -0.9504  | -0.7745 | 0.3495  | -1.4042  |
| DOCK2      | -0.6201 | -0.1022  | -0.155   | -0.4108  | -0.9991  | 0.5768   | 0.2624   | 0.8192   | 0.5184   | 1.1076   | -0.3603 | 1.3187  | 0.1331   |
| ELMO2      | -0.6201 | 0.01776  | 0.2706   | 0.09835  | -0.3921  | 0.02039  | 0.2952   | 0.5624   | -0.1598  | 1.0327   | 0.973   | 0.1321  | 0.4285   |
| UBE2Q1     | -0.6199 | 0.6407   | -0.2142  | -0.7308  | -0.3245  | -1.1162  | -0.1966  | -0.1499  | 0.3674   | 0.07657  | 0.7541  | 0.2386  | 0.1183   |
| ARL8B      | -0.6193 | 0.05755  | 0.421    | 0.4643   | 0.1078   | -0.1167  | -0.09477 | 1.7057   | -0.4913  | 0.5103   | 0.6889  | 0.9016  | 1.2084   |
| LOC391766  | -0.618  | -0.855   | -0.4293  | 0.9738   | 1.0564   | 0.8686   | 0.005558 | 1.8921   | -0.1287  | 1.1817   | 1.8342  | 1.7639  | 0.9626   |
| BUB1       | -0.6163 | -0.1934  | -0.7305  | -0.3751  | -0.1627  | -1.0933  | -0.8413  | 0.2726   | 0.03044  | -0.04143 | -0.5719 | -0.1701 | -0.3923  |
| FBXW11     | -0.6163 | -0.7557  | -2.1711  | -0.7814  | -0.00314 | -0.2638  | -2.6173  | -0.2326  | 0.4673   | -0.5355  | 0.2312  | -0.589  | -0.4238  |
| ZNF311     | -0.6159 | -0.06216 | -0.1778  | -0.476   | -0.6936  | -0.8339  | 0.7354   | 0.1409   | 0.2085   | 0.6923   | 0.08523 | 0.4175  | -0.00986 |
| UBE2G2     | -0.6142 | -0.2566  | -0.5713  | 0.9523   | -0.3965  | -1.4486  | -0.9303  | 0.6364   | 0.3423   | -0.3678  | 1.115   | 0.1266  | 0.2988   |
| ILDR1      | -0.6142 | 0.05235  | 0.2509   | -0.5233  | -0.05121 | 0.8046   | 0.4786   | 0.9781   | 0.04296  | 0.4792   | 1.0546  | 0.8852  | 0.6554   |
| SLC26A6    | -0.614  | -0.127   | 0.2358   | 0.122    | 0.2803   | 0.249    | 0.3772   | 0.5289   | -0.2582  | 0.9157   | 0.9122  | 0.4814  | 0.8682   |
| RARS2      | -0.6139 | -0.5665  | 1.4109   | 1.4099   | -0.3094  | -1.1173  | 0.1402   | 1.3291   | 0.4186   | 1.4991   | 0.5016  | 1.7768  | 1.3551   |
| SLC27A2    | -0.6134 | -0.445   | -0.365   | 0.1982   | -0.4091  | 0.7074   | -0.3125  | -0.2322  | 1.1816   | 0.1064   | 0.6199  | 0.6565  | 0.5431   |
| POLL       | -0.6123 | -0.3838  | 0.4129   | 0.5496   | 0.02346  | -0.6339  | -0.8799  | 0.4219   | -0.2501  | 0.109    | 1.0184  | 1.1155  | 0.7529   |
| ETV7       | -0.6119 | -0.04508 | 0.801    | 0.3521   | 0.203    | -0.2981  | 0.842    | 1.6305   | -0.05502 | 0.9945   | 0.801   | 1.6783  | 0.8197   |
| CALCRL     | -0.6112 | -0.994   | 0.07409  | -0.4096  | 0.4545   | 1.0747   | 0.02665  | 0.9646   | -0.1589  | 0.7076   | 1.231   | 0.6734  | 1.7093   |
| OR52I2     | -0.6108 | 0.5211   | 0.9161   | 0.457    | 0.06328  | -0.01013 | 0.2129   | 1.4853   | 0.7555   | 0.6293   | 0.08523 | 0.9233  | 1.7834   |
| CLDN8      | -0.6098 | 0.02634  | -0.00506 | 0.1732   | 0.4646   | -0.02081 | -0.283   | 0.4255   | 0.1799   | 0.7759   | 0.2935  | 0.04145 | 0.4857   |
| MATN3      | -0.6095 | 0.4467   | 0.7817   | -0.1794  | -0.3741  | -1.0399  | 0.3847   | 0.88     | 0.7648   | 0.5393   | 0.839   | 1.2169  | -0.1268  |

|          |         |          |          |          |          |          |          |          |          |          |         |          |          |
|----------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|----------|
| ZBTB39   | -0.6095 | 0.1061   | 0.4244   | -1.1581  | -0.02656 | -0.3544  | -0.02198 | 0.4484   | 0.009528 | -0.05945 | 0.6626  | 0.6116   | 0.3991   |
| GLRX2    | -0.6092 | -0.6525  | -0.8075  | -1.1475  | -0.01872 | -0.4438  | -0.4576  | -0.3946  | 0.1855   | 0.1096   | 1.2294  | -0.4625  | -0.4303  |
| LENG1    | -0.609  | -0.07654 | 0.285    | -0.2836  | -0.04133 | 0.3055   | -0.00601 | 0.2153   | 0.01123  | 0.7865   | 0.7162  | 0.1734   | 0.2599   |
| PML      | -0.6088 | 0.2901   | 0.2935   | -0.3038  | 0.05273  | 0.1208   | -0.1945  | 1.0976   | 0.5704   | 0.2174   | 0.7624  | 0.1594   | -0.06457 |
| SOC5     | -0.6077 | -0.00099 | -0.7153  | 0.4773   | -0.4053  | -1.3221  | -0.345   | 0.124    | 0.2085   | -0.4711  | 0.3     | 0.8328   | 0.5231   |
| ZNF585A  | -0.6067 | 0.2814   | 0.4345   | 0.9663   | 0.726    | -0.01059 | 0.5394   | 2.0319   | -0.629   | 2.2744   | 1.1218  | 1.4669   | 1.7056   |
| TIE1     | -0.6063 | -0.5742  | -0.437   | 0.1624   | 0.2791   | -1.001   | -0.5189  | 0.5972   | -0.05034 | 0.03724  | 0.1019  | 1.1871   | -0.2655  |
| PPIL3    | -0.6057 | -0.3347  | -0.3638  | 0.2443   | 0.07754  | 0.1858   | -0.898   | 0.2636   | 0.6875   | -0.2492  | 0.7748  | 0.4303   | 0.01897  |
| CDH7     | -0.6057 | 0.127    | 0.0222   | -1.144   | -0.00795 | 0.2402   | -1.2226  | 0.696    | 0.5313   | -0.0567  | -0.3231 | 0.5997   | 0.4855   |
| CDC42BPB | -0.6056 | 0.4129   | 0.1277   | -0.3474  | 0.2127   | -0.4124  | -0.5672  | 0.517    | 0.4612   | 0.03096  | 1.2399  | -0.01603 | 0.2947   |
| UGT1A7   | -0.605  | -0.534   | -0.2845  | -0.5506  | -0.3494  | 0.07882  | -0.2513  | -0.1438  | 0.5686   | -0.4094  | 0.02647 | -0.1668  | 0.4543   |
| CCRL1    | -0.6045 | -1.0121  | -0.2666  | 0.4077   | 0.1855   | -1.4882  | -0.3973  | -0.2677  | 0.4995   | 0.5104   | -0.5574 | 1.3728   | 1.4394   |
| SEPHS2   | -0.6042 | -0.2317  | 0.9776   | 0.4016   | 1.4947   | 0.2513   | -0.02343 | 1.1571   | 0.4001   | 1.0198   | 1.1622  | 1.547    | 1.3478   |
| TNIP1    | -0.6037 | 0.3345   | 0.4077   | -0.1243  | 0.0474   | -0.3956  | 0.9067   | 1.1638   | 0.542    | 0.4882   | 0.3994  | 0.5853   | 0.6347   |
| OR4D9    | -0.603  | 0.8801   | 0.1247   | -1.1213  | -0.5113  | -0.2035  | -0.5255  | 0.000341 | 0.2158   | 0.004793 | 0.8444  | 0.6743   | 0.7873   |
| TAF1L    | -0.6024 | -1.0609  | 1.2412   | -0.03751 | -0.1171  | -1.0578  | -0.8109  | 0.5145   | 0.8697   | 0.2296   | -0.3207 | 0.8086   | 1.6915   |
| COL9A1   | -0.6018 | 0.007418 | 0.05206  | -1.3738  | -0.1535  | 0.06887  | -0.5312  | -0.2977  | 0.1235   | 0.395    | 2.0552  | 0.1591   | 0.614    |
| HSD17B7  | -0.6016 | 0.003431 | 0.0902   | -0.575   | -0.07015 | -0.6688  | 0.1124   | -0.1927  | -0.216   | 0.743    | 0.6781  | 0.4001   | 0.2254   |
| MC5R     | -0.6013 | -0.5055  | -0.5217  | -0.3745  | -0.7646  | 0.05714  | -0.6109  | -0.3535  | -0.1147  | 0.2026   | 0.2779  | -0.1435  | -0.4891  |
| SLC17A4  | -0.6    | 0.1789   | -0.426   | -0.1878  | -0.3847  | -0.5646  | -0.1096  | -0.1705  | 0.5051   | 0.07353  | 0.2924  | -0.2109  | -0.02529 |
| PDP1     | -0.5996 | -0.4478  | -0.1029  | -0.1406  | -0.06566 | 0.4571   | -0.07407 | 0.3201   | 0.3455   | 0.3449   | -0.2825 | 0.4222   | 0.6143   |
| LMBR1    | -0.5994 | 0.07581  | 0.03797  | -1.3135  | -0.1852  | -1.3175  | -0.3889  | 0.7383   | 1.043    | -0.7012  | 0.9997  | -0.2935  | 0.05002  |
| DHTKD1   | -0.5994 | -0.3581  | 0.1285   | -0.2055  | -0.7326  | -0.359   | -0.7953  | -0.2353  | 0.05841  | -0.2066  | -0.1093 | -0.1777  | 0.0201   |
| GLUD1    | -0.5993 | -0.00898 | -0.03422 | -0.3252  | -0.3908  | -0.8477  | -0.1137  | 0.2571   | 0.2715   | -0.2253  | 0.3156  | -0.1779  | -0.1191  |
| RNF11    | -0.5984 | 0.05616  | 0.218    | -0.5629  | 0.01561  | -0.5655  | -0.3174  | 0.4016   | -0.3249  | 1.4199   | 0.3612  | 0.2504   | 0.04144  |
| OPN4     | -0.5982 | -0.6129  | -1.1896  | -0.8893  | -0.1945  | 0.2452   | -0.3846  | 0.5434   | 0.3622   | 0.4993   | 0.6746  | -0.7004  | -0.4745  |
| DNAJC27  | -0.5971 | -0.9224  | -0.1602  | -0.8964  | -0.047   | -1.504   | -0.5722  | 0.05063  | -0.6763  | -0.3508  | 0.6811  | -0.1241  | -0.1174  |
| ECD      | -0.5971 | -0.3532  | -0.4721  | -0.5952  | -0.9977  | -0.4801  | -0.3969  | -0.01857 | 0.08153  | 0.4016   | 0.04183 | -0.6289  | -0.7391  |
| CSN3     | -0.5969 | -0.5492  | 0.1018   | -0.2715  | 0.3251   | 0.003057 | -0.1935  | 0.2291   | 0.4118   | 0.5697   | 0.1946  | 0.05803  | -0.09362 |
| CCDC76   | -0.5961 | 0.02032  | 0.4382   | 0.1983   | 0.224    | -0.1587  | -0.2136  | 0.6602   | 0.2887   | 0.4459   | -0.2217 | 0.8162   | 1.6913   |
| UNG      | -0.5958 | 0.6059   | 0.5506   | -0.06114 | 0.9812   | -0.07485 | 0.6503   | 1.7405   | 0.2387   | 1.2702   | 1.4544  | 1.0662   | 0.4682   |
| SRD5A1   | -0.5957 | 0.313    | 0.6507   | 1.2975   | 0.2186   | -0.2046  | 0.8285   | 1.5093   | 0.517    | 1.7897   | 1.3744  | 0.3215   | 1.7133   |
| PTGR2    | -0.5951 | -0.3519  | 0.6198   | -0.8492  | -0.2254  | -1.0187  | -0.06401 | 0.1431   | 0.8344   | -0.04075 | 0.01041 | -0.04003 | 0.7625   |
| CLK2P    | -0.5948 | 0.05946  | -0.03356 | -1.2318  | 0.157    | -0.4393  | -0.4448  | -0.09782 | 0.303    | 0.007088 | 0.1308  | -0.06821 | 0.7059   |
| SNRPA    | -0.594  | -0.736   | -0.3515  | -0.0247  | -0.3609  | -0.6655  | -0.615   | -0.3692  | 0.2587   | 0.03628  | -0.4712 | -0.3476  | 0.6566   |
| ENOX2    | -0.5937 | 0.1478   | 0.5641   | -1.6485  | -0.384   | 0.4239   | -0.8754  | 0.7745   | -0.04457 | 0.1495   | 0.5756  | 0.4709   | 0.3873   |
| REM2     | -0.5922 | 0.1792   | -0.3849  | -0.3721  | 0.1764   | -0.5742  | -0.3063  | 0.4599   | -0.265   | 0.3073   | 0.9311  | 0.3181   | -0.276   |
| AGTR1    | -0.5921 | -0.1216  | 0.01443  | 0.9269   | -0.774   | -0.3244  | -0.828   | 0.8419   | 0.6182   | 1.3221   | 1.333   | -0.09975 | -0.3376  |
| PDE2A    | -0.5918 | -0.7804  | 0.9835   | -0.09052 | 0.3515   | -0.508   | -0.4218  | 1.3721   | 0.08207  | 0.323    | 1.0931  | 0.5271   | 0.2576   |

|             |         |         |          |          |          |          |          |          |          |          |          |         |          |
|-------------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|
| APOB        | -0.5908 | -0.3652 | -0.03251 | -0.2111  | -0.4702  | -0.3868  | 0.1356   | 1.1266   | 0.2921   | 0.4924   | -0.2437  | -0.4372 | 0.2386   |
| SETX        | -0.5905 | -0.1022 | 0.4634   | -0.1696  | -0.7909  | 0.212    | 0.558    | 0.5856   | 0.1715   | 1.1652   | -0.1228  | 1.3144  | 0.7921   |
| ANAPC11     | -0.5902 | 0.5688  | -0.7185  | 0.1963   | -0.3492  | -2.2267  | -1.0912  | 0.1594   | 0.09954  | -0.2778  | 0.289    | 0.2526  | 0.1027   |
| RAB4B-EGLN2 | -0.5901 | -0.7041 | -0.4854  | -0.2126  | 0.3638   | -0.0474  | 0.4264   | 0.9043   | -0.1598  | 0.04261  | 0.7941   | 0.7578  | 0.1976   |
| NKIRAS2     | -0.5895 | 0.2275  | 0.1594   | 0.1372   | 0.9115   | 0.224    | 0.8883   | 0.9146   | -0.2362  | 1.4164   | 1.059    | 1.7792  | 1.4069   |
| S100A14     | -0.5894 | -0.3014 | 0.3579   | -0.0356  | -0.1002  | -1.1505  | 0.05604  | 0.6875   | -0.1917  | 1.5683   | 0.6072   | 0.8373  | -0.3555  |
| MED27       | -0.5886 | -0.7638 | -0.4918  | 0.2755   | 0.1759   | -1.0695  | -0.3434  | 0.291    | 0.7794   | 0.002975 | 0.03348  | 0.09553 | -0.2935  |
| CRSP8P      | -0.5886 | -0.7638 | -0.4918  | 0.2755   | 0.1759   | -1.0695  | -0.3434  | 0.291    | 0.7794   | 0.002975 | 0.03348  | 0.09553 | -0.2935  |
| SOAT1       | -0.5886 | 0.3573  | 0.2861   | -0.07933 | 0.343    | -0.1155  | 0.2184   | 0.3785   | -0.101   | 0.6681   | 1.4539   | 0.4915  | 0.6606   |
| ABCB9       | -0.5883 | 0.1864  | 0.02917  | -0.06787 | 0.1359   | 0.2554   | -0.4048  | 0.5962   | -0.1305  | 0.4145   | 0.9798   | 0.6682  | -0.03831 |
| ENSA        | -0.5882 | 0.04489 | -0.09414 | -0.9426  | -0.5579  | 0.2395   | 0.689    | 0.3613   | 0.4066   | 0.1274   | 0.4313   | 0.1618  | 0.416    |
| BHLHE41     | -0.5881 | -0.366  | 0.3122   | -0.7949  | -0.07946 | -0.127   | -0.04148 | 0.4689   | 0.2291   | 0.4784   | 0.1504   | -0.4409 | 0.9134   |
| ZNF10       | -0.5877 | -0.3072 | 0.7548   | -0.4528  | 0.00351  | -0.706   | 0.05004  | 0.3748   | 0.771    | 0.08101  | 0.3883   | 0.2085  | 0.1785   |
| BBX         | -0.5873 | -0.2064 | 0.6353   | -0.1386  | -0.5248  | -0.3866  | -0.1364  | -0.00557 | 1.3231   | 0.7337   | -0.1666  | 1.1188  | -0.04804 |
| BCO2        | -0.5871 | -0.8703 | -0.3557  | -0.00457 | 0.4604   | -1.282   | -0.3671  | -0.06477 | 1.0195   | 1.4631   | -0.284   | -0.2329 | 0.3894   |
| NINL        | -0.5868 | -0.5238 | -0.1068  | 0.07331  | -0.4666  | -0.5485  | -0.6327  | 1.1612   | 0.7059   | -0.1031  | -0.4404  | -0.2297 | -0.1041  |
| CUTC        | -0.5867 | 0.06947 | -0.1003  | 0.6624   | 0.2227   | -0.8915  | -0.3182  | 0.2426   | 0.8364   | 0.7914   | -0.1558  | 0.6895  | 0.4343   |
| COX6A2      | -0.5863 | -0.8152 | -0.3712  | -0.1003  | -0.8352  | -0.5832  | -0.6588  | -0.5925  | 0.5285   | 0.2174   | 0.2739   | 0.1956  | -0.9537  |
| SNRPF       | -0.5859 | -1.8558 | -0.02873 | -0.3239  | -0.2574  | -1.3257  | -2.8714  | -0.8378  | 0.04516  | 0.5601   | -0.2067  | -0.6367 | 0.1631   |
| CCL21       | -0.5849 | -0.6125 | -0.3129  | -0.8239  | -0.109   | -0.6514  | -0.1587  | -1.0433  | -0.2823  | 0.3603   | 0.8988   | 0.09266 | 1.0966   |
| ZNF286A     | -0.5843 | 0.1323  | -0.7632  | -0.4605  | 0.2846   | -0.815   | -0.7975  | 0.6154   | -0.3021  | 0.1292   | 0.4297   | -0.3529 | 0.1433   |
| ARHGAP25    | -0.584  | -0.6214 | -0.3523  | -0.1854  | -0.5689  | -0.8644  | -0.4028  | -0.1315  | 0.7282   | -0.1974  | 1.0998   | -0.9134 | -0.1991  |
| PTPRK       | -0.584  | -0.665  | -0.6399  | 0.1806   | 0.2542   | 0.7292   | -0.7614  | 0.5084   | 0.2146   | 0.3073   | -0.1609  | 0.9674  | 1.1292   |
| ANXA1       | -0.5836 | 0.2124  | 0.2955   | 0.7604   | 0.1108   | 0.7303   | -0.01701 | 0.5257   | 0.4386   | 0.9193   | 0.3756   | 0.9357  | 1.1321   |
| MAPKAP1     | -0.5826 | -0.3284 | -0.3898  | 1.4139   | 0.9122   | 0.3321   | -0.3088  | 0.8467   | 0.4847   | 1.2025   | 0.585    | 0.9958  | 1.6238   |
| BAZ2A       | -0.5826 | 0.436   | -0.05799 | 0.681    | 0.8972   | 0.2119   | -0.5153  | 0.6419   | -0.06149 | 0.9511   | 1.4242   | 1.2627  | 1.1049   |
| TIAL1       | -0.5825 | 0.341   | -0.1889  | -0.05789 | -0.3317  | -0.8972  | 0.137    | 1.6371   | 0.3217   | -0.1301  | 0.0175   | 0.4442  | 0.3977   |
| GMFB        | -0.5825 | -0.5751 | 0.1263   | -0.06653 | -0.922   | 0.2743   | -0.9529  | 0.345    | -0.5704  | 0.003766 | 0.6981   | 0.8298  | 0.2211   |
| A4GALT      | -0.5823 | -0.4947 | -0.6543  | 0.04724  | -0.01926 | -0.00552 | 0.08817  | 0.2228   | -0.04254 | -0.08511 | -0.03937 | 0.4632  | 0.3955   |
| ARHGAP10    | -0.5822 | -0.2469 | -0.1708  | -0.7737  | -0.2802  | -0.4736  | -0.7246  | -0.6171  | 0.3652   | 0.3466   | 0.1385   | -0.5939 | 0.1718   |
| ZNF740      | -0.5818 | -0.8276 | 0.327    | 0.3892   | -0.4081  | 0.5942   | -0.9117  | 0.5852   | 0.1601   | 0.9189   | 0.6242   | -0.2256 | 1.1669   |
| MC2R        | -0.5816 | -0.1349 | 0.8155   | -0.9399  | -0.5439  | -0.634   | -0.2334  | 0.8826   | 0.295    | 0.5089   | 0.0443   | 0.7312  | -0.3817  |
| SLC6A8      | -0.5808 | -0.2758 | 0.1702   | 0.1637   | 0.09189  | -0.8833  | -0.2946  | 0.2452   | 0.2651   | 0.7017   | 0.2097   | -0.2625 | 0.3035   |
| RFX4        | -0.5801 | -0.3934 | -0.7761  | -0.5134  | -0.3512  | -0.1662  | 0.2214   | -0.1842  | -0.1779  | 0.2361   | 0.0564   | -0.2314 | 0.3143   |
| SLC10A5     | -0.58   | 0.13    | -0.7629  | 0.6741   | 0.399    | -0.2833  | -0.2091  | 0.4171   | 1.0196   | 0.005632 | 0.5351   | 0.8259  | 0.2412   |
| AP1S1       | -0.5799 | -0.8825 | 0.05606  | -0.7845  | -0.1434  | -0.3719  | 0.4131   | 0.5933   | -0.1927  | 0.0592   | 0.4014   | 0.4125  | -0.1304  |
| ALKBH5      | -0.5799 | -0.1318 | 0.003616 | 0.3778   | 0.6025   | -0.0659  | -0.0387  | 0.3377   | 1.0387   | 0.3729   | 0.5459   | 1.1861  | -0.07161 |
| EBF1        | -0.5797 | -0.4067 | -0.3133  | -0.08594 | -0.5911  | -0.1819  | -0.6822  | -0.7877  | 0.4324   | -0.4698  | 0.4082   | 0.2264  | 1.1613   |
| ZNF445      | -0.5795 | 0.09417 | -0.9368  | -0.1882  | -0.9118  | -0.203   | -0.5579  | 0.07537  | -0.02172 | -0.3306  | 0.137    | -0.3867 | 0.07316  |

|              |         |          |          |          |          |          |         |          |          |          |          |          |         |
|--------------|---------|----------|----------|----------|----------|----------|---------|----------|----------|----------|----------|----------|---------|
| RWDD3        | -0.5794 | -0.3993  | -0.6254  | -0.6431  | 0.631    | 0.2453   | 0.5394  | 0.6852   | 0.6919   | 0.4031   | -0.2704  | 0.8232   | 1.0209  |
| TMEM56-RWDD  | -0.5794 | -0.3993  | -0.6254  | -0.6431  | 0.631    | 0.2453   | 0.5394  | 0.6852   | 0.6919   | 0.4031   | -0.2704  | 0.8232   | 1.0209  |
| PIK3C2B      | -0.5793 | 0.3684   | 0.07176  | -0.3366  | -0.2727  | 0.7957   | -0.3115 | 0.1117   | 1.1027   | 0.4967   | 0.3579   | 0.7394   | 0.3192  |
| NCOA3        | -0.5792 | -1.2739  | -0.1728  | -0.7968  | -0.2877  | -0.6216  | 0.3297  | -0.0882  | 0.3672   | -0.6422  | 0.3478   | 0.05642  | 0.5739  |
| TNNI3K       | -0.5791 | -0.6972  | 0.3566   | 0.1531   | -0.08335 | 0.1254   | -0.6016 | -0.00381 | -0.454   | 0.8634   | 0.8784   | 0.7627   | 0.6059  |
| TAL1         | -0.5775 | -0.1362  | -0.4259  | -0.2193  | 0.06627  | -1.1539  | -0.1421 | -0.03046 | 0.4989   | -0.1342  | 0.8407   | 0.2411   | -0.3825 |
| NAMPT        | -0.5772 | -0.1679  | -0.1383  | -0.9888  | 0.3153   | 0.02581  | -1.0439 | -0.04288 | 0.3888   | 0.6291   | -0.3817  | 0.506    | 0.1402  |
| LSM1         | -0.5772 | -0.6     | 0.364    | 0.1636   | 0.1912   | -0.3329  | 0.2861  | -0.3504  | 0.3018   | 0.8118   | 0.7506   | 1.0999   | 0.55    |
| TRPM4        | -0.5764 | 0.0491   | -0.4364  | 0.5665   | 0.1695   | -0.7272  | -0.6076 | 0.394    | 0.6512   | 0.4631   | 0.8675   | -0.3566  | 0.2037  |
| STX3         | -0.5757 | -0.8841  | -0.2859  | 0.2232   | 0.3317   | -1.7447  | -0.1897 | 0.368    | 0.2489   | 1.1635   | -0.1614  | -0.1659  | 0.3652  |
| TONSL        | -0.5757 | -1.0422  | -0.3945  | -0.688   | -0.04595 | -1.4581  | 0.2284  | 0.4361   | 0.2149   | -0.1748  | -0.2955  | 0.5758   | -0.5022 |
| RALY         | -0.575  | -0.1576  | -0.08851 | -1.4369  | -0.2265  | -1.5489  | -0.4787 | -0.1903  | -0.06566 | -0.08634 | 0.07905  | -0.1496  | -0.5314 |
| EBPL         | -0.575  | 0.2772   | -0.2001  | -0.01525 | 0.4048   | 0.4128   | -0.7848 | 0.05609  | 0.255    | 0.2583   | 0.7285   | 0.7775   | 0.6541  |
| UBLCP1       | -0.5746 | -0.1647  | 0.6385   | -0.1217  | -0.3395  | -0.2932  | -0.5198 | 0.633    | 0.05837  | 0.7849   | 1.1963   | 0.08832  | -0.2771 |
| ALG10        | -0.5742 | 0.05468  | 0.4151   | -0.4623  | 0.07029  | -0.3075  | -1.1386 | -0.3361  | 0.1389   | 0.2596   | 1.2137   | 0.682    | 0.3488  |
| CTRL         | -0.5741 | -0.476   | -0.3363  | 0.5243   | -0.2319  | -1.1583  | -0.9386 | 0.05547  | -0.4627  | 0.8366   | 0.2404   | -0.2143  | 1.7386  |
| GPR179       | -0.574  | 0.3769   | -0.3078  | -1.2841  | -0.06438 | -0.5672  | 0.3688  | 0.3331   | 0.9084   | 0.8303   | 0.02363  | -0.02359 | 0.05891 |
| MCM6         | -0.5738 | 0.9491   | 0.7165   | 1.4352   | 0.3933   | -0.4405  | 0.5443  | 1.5405   | 0.3284   | 1.458    | 1.452    | 1.0025   | 1.7427  |
| CYP51A1      | -0.5737 | -0.4567  | -0.6688  | 0.237    | 0.1914   | 0.5781   | -0.2191 | 0.3143   | -0.3377  | 0.5654   | 0.9634   | 0.5209   | 0.8622  |
| ACP5         | -0.5729 | -0.8489  | -0.5775  | 0.232    | -0.7892  | -1.1005  | -0.7794 | 0.3167   | 0.1724   | -0.3709  | -0.03073 | -0.3626  | -0.6947 |
| PGM2         | -0.5728 | -0.05637 | 0.5677   | 0.2256   | -1.0601  | -0.1125  | -0.0767 | 0.01649  | 1.1675   | 0.7919   | 0.185    | 0.638    | 0.1151  |
| ZNF224       | -0.5727 | 0.4363   | 0.1487   | -0.9366  | 0.7311   | 0.6794   | 0.4309  | 0.5853   | 0.481    | 1.2832   | 1.8859   | 1.1322   | 0.3005  |
| LALBA        | -0.5722 | -0.6864  | 0.519    | -0.3289  | 0.1726   | -0.1968  | -0.5962 | 0.5432   | 0.2279   | 0.4669   | 0.7135   | -0.4537  | 0.3733  |
| NTF3         | -0.5721 | -1.5782  | -0.5619  | -0.4533  | -1.2361  | -0.5616  | -0.8254 | 0.4765   | -0.0431  | -0.8302  | 0.1181   | -0.2763  | -1.0935 |
| DDX59        | -0.5719 | 0.1624   | -0.2621  | -0.3749  | -0.4681  | 0.241    | -0.6473 | 0.9571   | -0.3889  | 0.3348   | -0.123   | 0.2537   | 0.4347  |
| ZSCAN29      | -0.5715 | 0.2878   | 0.2654   | 0.03423  | 1.0609   | -0.7686  | -1.4988 | -0.4132  | 0.4753   | 0.8373   | 1.5152   | 1.5533   | 1.0207  |
| LOC100508943 | -0.5699 | -0.0749  | -0.7261  | -0.5609  | -0.294   | -0.7811  | -0.4578 | 0.2066   | 0.2256   | 0.7708   | -0.5309  | -0.6893  | -0.1188 |
| SLC39A1      | -0.5696 | 0.8406   | 0.3772   | -0.2815  | -0.2302  | 0.2437   | -0.1488 | 1.7225   | 0.3709   | 1.1289   | 0.3947   | 0.4846   | 0.201   |
| UBR2         | -0.5695 | -0.9031  | -1.1504  | -0.5666  | -0.6108  | -0.3109  | -0.3273 | 0.07508  | -0.2297  | -0.01817 | -0.534   | -0.7264  | -0.2736 |
| BCAR1        | -0.569  | 0.2903   | -1.1888  | 0.6874   | -0.8     | -1.2715  | -0.5529 | -0.1163  | 0.1772   | 0.4352   | -0.04331 | 0.6641   | -0.1182 |
| HSPB8        | -0.5669 | -0.5133  | 0.1946   | -0.7776  | 0.4223   | -0.8119  | -0.2764 | -0.2094  | 0.1426   | 0.1459   | 0.4455   | -0.09378 | 0.5176  |
| DGCR2        | -0.5667 | 0.3615   | 1.008    | 0.4973   | -0.2132  | -1.4234  | 0.1005  | 0.3084   | 1.0047   | 0.1983   | 1.4124   | 1.0293   | 0.7804  |
| OR51T1       | -0.5657 | -1.0658  | 0.4789   | -0.07855 | 1.08     | 0.2797   | -0.1431 | 0.594    | 0.6169   | 1.5058   | 0.07315  | 0.82     | 1.0004  |
| PHLPP1       | -0.5656 | 0.2635   | -0.0742  | 0.02948  | 0.1488   | 0.2661   | -1.1373 | 0.4292   | 0.9563   | 0.3288   | -0.2364  | 0.5155   | 0.6617  |
| WISP1        | -0.565  | 0.3111   | -0.2686  | -0.01719 | -0.567   | -0.4891  | -0.5611 | 0.1092   | -0.0189  | -0.1869  | -0.2401  | 0.6242   | 1.099   |
| SEC23IP      | -0.5648 | 0.08158  | -0.1597  | 0.001422 | -0.106   | -0.8424  | -0.2645 | 0.2736   | 0.6655   | -0.04932 | 0.9723   | 0.379    | -0.5721 |
| RHAG         | -0.5648 | 0.1142   | -0.08538 | -0.6082  | 0.2355   | -0.06025 | 0.3612  | 0.6844   | -0.01396 | 1.2076   | 0.6796   | -0.4171  | 1.1671  |
| LRRN2        | -0.5646 | -0.7206  | 0.3229   | -0.0617  | 0.069    | 0.9009   | 0.09888 | 0.8553   | 0.2219   | 0.8173   | -0.04191 | 1.3611   | 0.9079  |
| GMEB1        | -0.5638 | -0.1789  | 0.7175   | 0.2042   | -0.4416  | 0.06768  | 0.6182  | 0.9434   | 0.02474  | 0.1943   | 1.0037   | 0.7481   | 1.1605  |

|              |         |          |          |          |          |         |          |          |          |          |          |          |         |
|--------------|---------|----------|----------|----------|----------|---------|----------|----------|----------|----------|----------|----------|---------|
| TXNDC8       | -0.5635 | -0.1562  | 0.9174   | 0.5252   | 0.3736   | -1.0213 | -0.198   | 0.01453  | 1.3536   | 0.8052   | 0.4895   | 1.1421   | 0.5721  |
| CSNK2B       | -0.5624 | -0.727   | -0.4215  | -0.8845  | -0.4138  | -0.2469 | 0.02357  | -0.273   | 0.3803   | -0.05956 | -0.03038 | -0.5602  | 0.03783 |
| P2RY6        | -0.5621 | 0.08706  | -0.4692  | -0.0988  | -0.4566  | 0.3879  | -0.247   | 0.1492   | -0.2994  | 1.286    | 0.07252  | 0.9837   | 0.1749  |
| SPEG         | -0.5617 | 0.5654   | 0.7858   | -0.2988  | -0.08074 | 0.209   | 0.03168  | 0.9224   | 0.4534   | 0.6519   | 1.0976   | 0.1059   | 0.5417  |
| PPYR1        | -0.5616 | 0.4619   | 0.6819   | -1.3461  | -0.2293  | 0.1015  | 0.3877   | 0.3923   | 0.8202   | 0.6374   | 0.9042   | 0.06954  | 0.7741  |
| PEX19        | -0.5614 | -0.2548  | 0.8721   | 0.09214  | -0.9623  | -1.5091 | 0.2255   | 0.01223  | 0.2419   | 1.7082   | 0.3494   | 0.9216   | 0.2499  |
| TTLL4        | -0.5614 | -0.837   | -0.4207  | 0.1714   | -0.8492  | 0.5208  | 0.2018   | 1.1008   | 0.4329   | 0.804    | -0.3932  | -0.07038 | 0.819   |
| BCL9L        | -0.5609 | 0.3276   | 0.4279   | -0.4186  | -0.6851  | 0.3676  | -0.4942  | 1.0452   | 0.789    | 0.674    | 0.2883   | -0.1837  | 0.1465  |
| BZRAP1       | -0.5608 | 0.1045   | -1.0287  | 0.6207   | 0.3539   | 0.9392  | 0.02891  | 1.5222   | 0.1379   | 1.278    | 0.1363   | 1.5209   | 0.8703  |
| RWDD3        | -0.5606 | 0.3012   | -0.01979 | 0.5714   | -0.4832  | -0.4334 | -0.3176  | 0.009448 | -0.03828 | 0.4278   | 1.0094   | 0.5325   | 0.4057  |
| TSHZ3        | -0.5599 | -0.1847  | -0.1691  | -1.1428  | -0.1577  | -0.6868 | 0.3755   | 0.6133   | 0.5234   | 0.03761  | 1.2422   | -0.7542  | 0.3601  |
| FPR2         | -0.5598 | 0.2801   | -0.4612  | -0.697   | 0.2257   | -0.2788 | -0.7184  | -0.1228  | -0.07103 | 0.2555   | -0.1663  | 0.391    | 0.5745  |
| TBCK         | -0.5596 | 0.205    | 0.233    | -0.488   | 0.09602  | -0.2889 | 0.2306   | 0.4855   | -0.09614 | 0.2523   | -0.02127 | 1.0151   | 1.1481  |
| ATP6V1F      | -0.5595 | -0.6656  | 0.4089   | -0.3919  | -0.3121  | 0.3506  | -1.0082  | 0.3955   | 0.9488   | 0.5142   | 0.2878   | 0.1194   | -0.4511 |
| LOC100505587 | -0.5595 | -0.6656  | 0.4089   | -0.3919  | -0.3121  | 0.3506  | -1.0082  | 0.3955   | 0.9488   | 0.5142   | 0.2878   | 0.1194   | -0.4511 |
| CNOT8        | -0.5582 | -0.3043  | 0.5584   | -0.2661  | 0.3418   | -0.3173 | -2.1559  | 1.0331   | 0.3248   | 0.7071   | 0.5307   | 1.1373   | -0.586  |
| ZBTB22       | -0.5574 | 0.04368  | -0.4712  | -0.6928  | -0.1479  | 0.6561  | 0.09817  | 0.3295   | -0.2999  | 0.3107   | 1.4982   | 0.587    | 0.6064  |
| TXNRD1       | -0.5571 | -0.0742  | 0.161    | -0.04658 | -0.01027 | -0.4161 | -0.4083  | 0.9209   | 0.2903   | -0.2176  | -0.2636  | 0.4006   | 0.314   |
| USP37        | -0.5568 | -1.2133  | 0.01589  | -0.9925  | -0.555   | -0.5451 | -1.3166  | -0.2837  | 0.5924   | -0.241   | -0.3187  | -0.9606  | -0.0467 |
| LOC100290936 | -0.5567 | -0.08351 | -0.5687  | -0.2849  | -0.7632  | 0.2167  | -0.1147  | 0.2617   | 0.9851   | -0.2703  | 0.1914   | -0.2244  | 0.1526  |
| PAICS        | -0.5566 | -0.00013 | -1.0409  | -0.1161  | 0.4176   | -0.2161 | -0.7326  | 0.3965   | -0.3401  | 0.6227   | -0.1537  | 1.2412   | 0.2004  |
| UGT2B4       | -0.5565 | -0.05662 | 0.8517   | 0.339    | 1.1757   | 0.2668  | 0.1987   | 1.7399   | 0.07782  | 0.2036   | 1.6645   | 2.0961   | 1.3526  |
| KRT3         | -0.5564 | 0.0604   | -0.05476 | 0.2758   | -0.2677  | -0.3912 | -0.6628  | 0.1654   | -0.2415  | 0.4675   | 0.5372   | 0.6664   | -0.2094 |
| PLA2G10      | -0.5564 | 0.1762   | 0.2691   | -0.02205 | 0.3319   | -0.6957 | -0.4665  | 0.4482   | -0.009   | 0.9591   | 0.6908   | 0.02935  | 0.1765  |
| CASP14       | -0.5564 | -0.5698  | 0.09626  | -1.7694  | -0.926   | 0.1259  | -0.01103 | -0.1884  | 0.454    | 0.06544  | 0.8315   | -0.6288  | 0.9245  |
| ST6GALNAC6   | -0.5563 | -0.2749  | -0.2815  | -0.5539  | 0.3711   | -0.6652 | -0.1215  | 0.3383   | -0.1978  | 0.9513   | 0.1238   | 0.09834  | -0.1939 |
| C15orf42     | -0.5558 | -0.831   | -0.07856 | -0.05648 | 0.03867  | -0.5511 | -0.7942  | 0.04269  | 0.9365   | -0.4232  | 0.8569   | 0.3687   | -0.6016 |
| PKN1         | -0.5553 | -0.1026  | 0.361    | -1.8089  | -0.3042  | 0.3241  | 0.02692  | 0.1345   | -0.0829  | 0.3707   | 0.6586   | 1.1761   | 0.3822  |
| RAGE         | -0.5542 | -0.3098  | 0.519    | 1.344    | 0.6632   | 1.2248  | 0.4075   | 2.165    | -0.4583  | 0.9983   | 1.739    | 2.3381   | 4.0214  |
| SLC22A1      | -0.5541 | -0.1231  | -1.2866  | 0.8251   | 0.4855   | 0.2323  | -1.4041  | 0.6861   | 0.6262   | 0.827    | 0.3627   | -0.09109 | 0.4932  |
| CCNB1IP1     | -0.5527 | -0.2781  | 0.06567  | -0.3053  | 0.3826   | -0.1329 | -0.3775  | 0.1889   | -0.8305  | 1.0841   | 0.7157   | 0.5417   | 0.8982  |
| CDC42EP2     | -0.552  | -0.523   | -0.4064  | -0.2277  | -0.3508  | -0.0193 | 0.4381   | -0.07221 | 0.5695   | 0.4585   | -0.4887  | 0.632    | 0.4276  |
| GUCY2E       | -0.5519 | -0.6275  | -0.3067  | -0.04743 | -0.2361  | -0.3727 | 0.1894   | -0.4117  | -0.3879  | 0.6732   | 0.9805   | 0.4962   | 0.07788 |
| SNRPE        | -0.5519 | -0.7639  | -0.441   | 0.9699   | 0.2984   | -1.5201 | -1.7663  | 0.1022   | 0.5689   | 0.8595   | -0.1834  | 0.5203   | -0.182  |
| CLTB         | -0.5517 | 0.03209  | -0.7342  | -1.4604  | -1.3331  | 0.9635  | -0.9223  | 0.1632   | -0.3762  | 0.2588   | 0.4889   | -0.2278  | 0.4904  |
| MMAA         | -0.5514 | 0.7333   | 1.7641   | 0.2692   | 0.8288   | -0.5011 | 0.5794   | 2.0214   | 0.295    | 1.6663   | 1.7635   | 0.9198   | 1.5908  |
| SLC41A1      | -0.5514 | -0.09209 | -0.1603  | -0.00504 | -0.3959  | -1.059  | -0.2191  | 0.1937   | 0.002559 | -0.4316  | 0.5254   | 0.1204   | -0.0327 |
| OR4C11       | -0.5513 | -0.607   | -0.5109  | -0.3293  | 0.8621   | -0.2273 | -0.2803  | 0.7171   | -0.3688  | -0.1587  | 0.2733   | 1.1263   | 1.4739  |
| NACA2        | -0.5513 | -0.4791  | -1.1456  | 0.1706   | -0.6639  | -2.5398 | -1.5229  | -0.2425  | 0.3435   | -0.2097  | -0.3944  | -0.1322  | -0.9984 |



|          |         |          |          |          |          |          |          |          |          |          |          |          |          |
|----------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| EFCAB7   | -0.5511 | -0.076   | -0.5511  | -0.4798  | -0.1852  | -0.5437  | -0.1789  | 0.114    | 0.5189   | -0.1249  | -0.0637  | -0.1782  | -0.4779  |
| UGT1A5   | -0.5504 | -0.3749  | 0.1209   | -0.4066  | 0.5015   | -0.4032  | -0.4794  | 0.8187   | 0.3056   | 0.5354   | -0.2887  | -0.1869  | 0.5276   |
| TRIM13   | -0.5502 | 0.9011   | 1.4617   | -0.3939  | -0.6265  | -1.0062  | -0.1322  | 1.6408   | -0.5248  | 1.3635   | 1.7841   | 0.4048   | 1.7708   |
| EDEM2    | -0.5498 | -1.1033  | 0.0116   | -0.2783  | 0.4244   | 0.2496   | -0.9279  | -0.1339  | 0.4203   | 0.007143 | 1.4314   | -0.1531  | 1.0998   |
| DNTT     | -0.5498 | -0.2617  | -0.6111  | -0.6026  | -0.1696  | -0.4236  | 0.07047  | 1.2635   | -0.1374  | 0.2242   | 0.1736   | -0.9491  | 0.8503   |
| KCNJ4    | -0.5497 | 0.5947   | 1.2179   | 2.3837   | 0.9005   | 1.1455   | 0.6351   | 1.8424   | 0.4694   | 2.041    | 3.43     | 2.2305   | 2.1572   |
| SEC24C   | -0.5476 | 0.1061   | 0.2886   | 0.2472   | -0.1958  | -0.3952  | -0.1563  | 0.2101   | -0.5774  | 0.6294   | 0.3631   | 1.1847   | 1.1418   |
| ADAMTS6  | -0.5466 | -0.3047  | -0.1206  | 0.1034   | -0.667   | 0.7149   | -0.03046 | 0.3598   | 0.7756   | 0.6182   | 0.5753   | -0.0571  | 0.03364  |
| TGM7     | -0.5462 | 0.2383   | -0.5501  | 0.2507   | -0.5825  | -0.06216 | -0.9497  | 0.7604   | 0.2216   | 0.6078   | 0.6982   | 0.1803   | -0.7113  |
| PAX7     | -0.5459 | 0.2476   | 0.4408   | 1.331    | -0.2481  | 1.4612   | 1.9711   | 2.1108   | 0.5426   | 2.0614   | 1.139    | 2.226    | 2.2148   |
| PNCK     | -0.5456 | 0.07244  | -0.00559 | -0.4121  | -0.6745  | 0.2709   | -0.3435  | -0.02    | -0.00628 | 0.05754  | 0.5471   | 0.1501   | 0.03562  |
| RNASE2   | -0.5455 | -0.2259  | 0.4326   | -0.3048  | 0.4998   | -0.3006  | -0.3553  | 0.7149   | -0.377   | 0.7199   | 0.5915   | 0.1612   | 0.6789   |
| AGAP7    | -0.5454 | -0.3056  | -0.3266  | -0.128   | -0.01277 | 1.0064   | -0.04176 | -0.1563  | 1.8787   | 0.5101   | 0.7169   | 0.2336   | 0.9026   |
| SUDS3    | -0.5453 | -0.6372  | 0.3864   | -0.8394  | -0.3287  | -0.2481  | -0.296   | -0.01707 | 0.118    | 0.7027   | 0.9128   | -0.5343  | -0.03868 |
| H2BFM    | -0.545  | -0.0292  | 0.3952   | -0.1919  | 0.09811  | 0.4168   | -0.4624  | 0.2009   | 0.4363   | 0.3552   | -0.00384 | 0.9801   | 0.454    |
| SYT15    | -0.5439 | -0.5262  | -0.1234  | -0.3611  | -0.3163  | -0.5313  | -0.349   | -0.8387  | -0.01728 | 0.155    | 0.5404   | -0.2523  | 0.2647   |
| PCYOX1L  | -0.5437 | -0.06397 | -0.1294  | 0.2142   | -0.3911  | 0.1983   | -0.4545  | -0.01325 | 0.5716   | 0.1121   | -0.3338  | 0.8364   | 0.5525   |
| USF2     | -0.5437 | -0.4205  | -1.0792  | 0.3209   | 0.09068  | -0.4427  | -0.5354  | 0.252    | 1.136    | -0.1608  | 0.0266   | 0.5306   | -0.4275  |
| APC      | -0.5433 | 0.3473   | -0.05531 | -0.0314  | 0.2578   | -0.2975  | -0.3499  | -0.00179 | 0.3819   | 0.3825   | 0.1359   | 0.322    | 0.1033   |
| PCDHGB4  | -0.5427 | -0.6396  | 1.0021   | 0.1056   | -0.1905  | 2.0834   | 0.1262   | 1.9557   | -0.8091  | 1.7098   | 1.469    | 3.133    | 2.692    |
| TOMM22   | -0.5427 | -0.7417  | -0.2877  | -0.02011 | -0.02968 | -0.01676 | 0.04635  | 0.2203   | 0.6008   | 0.5724   | -0.6579  | 0.7196   | 0.1271   |
| SMPDL3A  | -0.5423 | 0.002455 | 0.3588   | -0.5952  | 0.4343   | -0.1585  | -0.1977  | 0.427    | 0.8022   | 0.003941 | 0.5165   | -0.08292 | 0.5254   |
| HNRNPM   | -0.5413 | -0.7231  | -1.3281  | -0.5025  | -0.4313  | -1.9351  | -1.2653  | 0.2357   | 0.4724   | 0.1002   | -0.4559  | -1.824   | -0.1413  |
| CREG1    | -0.5408 | 0.02444  | 0.1341   | -0.006   | 0.1938   | -1.0628  | -0.5111  | 0.6678   | 0.7605   | 0.5196   | 0.1322   | 0.04932  | -0.3685  |
| CACNA2D1 | -0.5406 | -0.07873 | 0.458    | -0.318   | 0.06965  | -0.7838  | -0.4439  | 0.4172   | 0.1749   | 0.3881   | 0.2789   | 0.3035   | -0.3446  |
| YSK4     | -0.5405 | -0.04167 | 0.9576   | 0.1887   | -0.7657  | -0.7156  | 0.3876   | 1.0927   | -0.2954  | 0.841    | 1.1307   | 0.1907   | 1.1616   |
| SLC2A4   | -0.5399 | 1.0042   | 0.7989   | 0.0404   | 0.4448   | -1.2016  | -0.3969  | 1.4781   | 0.5184   | 0.3241   | 0.2536   | 1.2982   | 1.2485   |
| SGPP1    | -0.5396 | 0.1228   | 0.4428   | 0.293    | -0.1756  | -0.1063  | -0.4429  | 0.7774   | 0.7012   | 0.7963   | 0.1641   | 0.09097  | -0.07346 |
| KCNJ2    | -0.5391 | -0.3655  | 0.6396   | 0.6488   | -0.3571  | 0.4145   | 0.7092   | 1.1792   | -0.5464  | 1.7065   | 0.9584   | 1.9234   | 0.9241   |
| HES3     | -0.5381 | -0.3128  | -0.933   | -0.7681  | 0.3479   | -0.2786  | -0.2293  | -0.1739  | -0.00521 | 0.2133   | 0.2737   | -0.1984  | -0.1558  |
| EFNB1    | -0.5381 | -0.4025  | 0.403    | -1.1071  | -0.3969  | 0.2127   | -1.1755  | 0.2373   | -0.2476  | 1.2682   | 0.6941   | 0.03272  | -0.3594  |
| WNT1     | -0.5379 | 0.3529   | 0.1163   | -0.5284  | -0.4225  | 0.000238 | -0.6394  | 0.5018   | -0.4933  | 1.0213   | 0.003007 | 0.2349   | 0.5831   |
| NFKBIA   | -0.5372 | -0.5786  | -0.503   | -0.9541  | 0.2633   | -1.4663  | -0.2237  | -0.194   | 0.4372   | 0.1127   | 0.9997   | -0.8697  | -0.01271 |
| ACAT2    | -0.5371 | 0.1384   | -0.3168  | 1.5247   | 0.4582   | 0.6958   | 0.08068  | 2.115    | -0.3043  | 1.7398   | 0.9229   | 1.5925   | 1.317    |
| KIR3DS1  | -0.5371 | -0.4527  | -0.07088 | -0.1872  | -0.3722  | -0.5926  | -0.1291  | 0.08447  | -0.3805  | 0.4169   | -0.3114  | 0.4386   | -0.2207  |
| LDHAL6B  | -0.5369 | -0.9418  | 0.709    | 0.8137   | -0.2393  | -0.5263  | 0.05793  | 1.2724   | 0.2203   | 0.9388   | -0.1757  | 0.8298   | 0.6997   |
| CD79B    | -0.5366 | 0.2789   | -0.3537  | -0.0142  | 0.437    | 1.2693   | -0.4185  | 1.26     | 0.2157   | 0.4682   | 0.6034   | 1.706    | 0.728    |
| GPX3     | -0.5362 | -0.1492  | -0.5858  | -0.1343  | 0.2636   | -0.4621  | -0.8027  | 0.2435   | -0.2914  | -0.498   | 0.4995   | 0.3072   | 0.4032   |
| GPD1     | -0.5362 | -0.3249  | -0.6115  | -0.4656  | -0.375   | -1.0888  | 0.6579   | -0.07882 | 0.2615   | 0.5099   | -0.1606  | 0.7862   | -0.312   |

|              |         |          |          |          |          |          |          |          |          |          |         |          |          |
|--------------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------|----------|----------|
| MLKL         | -0.5361 | 0.1077   | 0.01984  | -0.8     | 0.2429   | -0.3716  | -0.3283  | -0.05331 | 0.5261   | -0.377   | 0.7208  | 0.6784   | 0.05727  |
| HNRNPCL1     | -0.5356 | 0.1064   | 0.2858   | -0.6108  | 0.2886   | -0.6142  | -0.3857  | -0.2567  | 0.3421   | 0.5616   | 0.5563  | 0.1265   | 0.1287   |
| HERPUD1      | -0.5356 | 0.1588   | 0.4095   | 0.8366   | 0.01803  | -0.01436 | -0.2517  | 0.9596   | 0.2712   | 0.5386   | 0.4755  | 0.2569   | 0.7871   |
| IARS2        | -0.5355 | -0.9054  | -0.9827  | 0.4694   | -0.1336  | -1.3997  | -2.1923  | -0.5931  | 0.3826   | -0.1314  | -0.6029 | -0.1971  | 0.5773   |
| LOC100507855 | -0.5355 | -0.6791  | -0.4096  | -0.5602  | 0.1069   | -0.5665  | -0.2275  | 0.6328   | 0.2051   | -1.1293  | -0.2041 | 0.5469   | 0.9288   |
| LOC100293160 | -0.5354 | -0.4713  | -0.5887  | -0.5788  | -0.07976 | -0.3396  | -0.3398  | -0.1038  | 0.2529   | 0.08613  | -0.6569 | -0.1472  | -0.22    |
| ZNF765       | -0.5354 | -0.2407  | -0.3266  | -0.05654 | 0.09979  | -0.5267  | 0.06202  | 0.1036   | 0.5089   | -0.04183 | 0.5131  | 0.3434   | -0.443   |
| PRDM2        | -0.5352 | -0.4947  | -0.01348 | 0.4356   | 0.6647   | -3.0704  | -0.7527  | 0.8047   | -0.09267 | 0.2056   | 0.752   | 1.4629   | -0.07185 |
| GTF2IRD1     | -0.5352 | -0.03254 | -0.1489  | 0.4918   | 0.13     | -0.7321  | 0.1472   | -0.1317  | 1.0656   | 0.2862   | 0.09743 | 0.3577   | 1.3309   |
| DDX24        | -0.5349 | -1.0678  | -0.3832  | -0.08447 | -0.7196  | 0.1608   | -0.09225 | 0.4459   | -0.3173  | 0.11     | -0.416  | 0.3512   | 0.2636   |
| ALOX5AP      | -0.5331 | -0.07816 | -0.7176  | 0.0459   | -0.5378  | -1.6489  | -0.1624  | -0.1477  | 0.7206   | -0.517   | -0.538  | 0.7786   | 0.5872   |
| SPIC         | -0.5313 | 0.5387   | 0.9254   | -0.2423  | -0.2369  | -0.5905  | 0.01328  | 0.9412   | -0.03145 | 0.01938  | 1.4144  | 0.4958   | 1.4934   |
| IQCJ-SCHIP1  | -0.5305 | 0.5168   | 0.7506   | -0.00791 | -0.01761 | -0.7915  | -0.0274  | 0.4007   | -0.1104  | 0.8074   | 0.4502  | 0.7876   | 1.4545   |
| PCDHB14      | -0.53   | -0.2402  | 0.1666   | -0.6054  | 0.9511   | 0.04962  | -0.4355  | 0.4841   | 0.7518   | 0.3508   | 0.8019  | -0.1458  | 0.4979   |
| ECHS1        | -0.5286 | -0.3643  | -0.7534  | -0.5549  | -0.09365 | -0.4093  | 0.2923   | -0.08681 | 0.6113   | 0.3893   | 0.8339  | -0.2813  | -0.501   |
| GLMN         | -0.5285 | -0.5485  | 0.8686   | -0.4865  | -0.3596  | 0.8112   | -0.3662  | 1.4096   | -0.5952  | 0.9978   | 0.3914  | 2.0831   | 0.6453   |
| FRMD1        | -0.5285 | 0.1416   | -0.07727 | 1.115    | 0.000571 | -0.5304  | -1.2205  | 0.5021   | 1.0662   | 0.1703   | 0.9327  | 1.5602   | -0.264   |
| FH           | -0.5284 | -0.00834 | -0.8295  | 0.02518  | 0.8059   | -0.07402 | -0.2953  | 0.6337   | 0.1033   | 0.5742   | 0.3888  | 0.5328   | -0.04821 |
| RHO          | -0.5277 | -0.3154  | 0.8438   | 0.2238   | 0.4112   | -0.5919  | -0.4028  | 1.0924   | -0.4347  | -0.1137  | 1.0875  | 1.3318   | 1.5686   |
| PAMR1        | -0.5265 | -0.385   | 0.1725   | -0.05901 | 0.3991   | 0.1316   | -0.1089  | 0.5793   | 0.4526   | 0.7882   | 0.08361 | 0.8399   | -0.3237  |
| TNFRSF10A    | -0.5257 | 0.1114   | 0.0541   | -0.9057  | -0.7845  | 0.02814  | 0.4013   | -0.2373  | 0.8627   | 0.7012   | -0.2338 | 0.8111   | 0.2788   |
| PCDHGB7      | -0.5257 | 0.6859   | 1.468    | 1.2752   | 0.744    | 2.2718   | -0.07117 | 2.2857   | -0.144   | 2.7312   | 1.8503  | 3.9066   | 2.4736   |
| QTRT1        | -0.5254 | -0.7866  | -0.02687 | 0.002262 | -0.6619  | -0.2325  | -0.1005  | 0.1893   | 0.619    | -0.09856 | -0.2953 | -0.2094  | 0.1114   |
| ALG1         | -0.5251 | 0.8431   | -0.1177  | 0.08425  | -0.4014  | -1.1289  | -0.1466  | 1.2909   | 0.301    | 0.9846   | -0.1887 | -0.1463  | 0.8723   |
| LOC650368    | -0.5251 | 0.8431   | -0.1177  | 0.08425  | -0.4014  | -1.1289  | -0.1466  | 1.2909   | 0.301    | 0.9846   | -0.1887 | -0.1463  | 0.8723   |
| GRIK2        | -0.5246 | -0.03935 | 0.79     | -0.1261  | 0.5461   | -1.3081  | -0.9974  | 0.8863   | 0.2992   | 0.2036   | 0.03651 | 1.1568   | 0.2766   |
| NEIL3        | -0.5243 | 0.4008   | -0.4452  | -0.407   | 0.2058   | -1.0028  | -0.2244  | 1.1663   | -0.07003 | 1.6105   | -0.2922 | -0.2028  | 0.3765   |
| GLUD2        | -0.5243 | 0.27     | 0.1295   | -0.5907  | -0.375   | 0.2021   | 0.2242   | 0.7894   | 0.1918   | 0.4936   | 0.1767  | -0.07732 | 0.3768   |
| GFI1         | -0.5242 | -0.7351  | -0.06699 | 0.463    | -1.1318  | -0.1354  | -0.1744  | 0.3899   | -0.08098 | 0.5727   | 0.3398  | -0.5357  | 0.8237   |
| POLR3C       | -0.5239 | 0.3168   | 0.9089   | -0.2008  | -0.4503  | 1.0185   | 0.6895   | 1.4811   | -0.3262  | 1.0513   | 0.7353  | 2.0529   | 1.9899   |
| EPHA6        | -0.5229 | -0.6694  | 0.2716   | 0.5089   | 1.0056   | 0.2223   | -0.05763 | 1.1059   | -0.4155  | 0.9934   | 1.0552  | 0.879    | 1.451    |
| RHBDL3       | -0.5226 | 0.2539   | 0.4365   | -0.01703 | -0.2036  | 0.3083   | 0.1632   | 0.9619   | 0.05877  | 0.1961   | 1.2267  | 0.9529   | -0.01948 |
| RICTOR       | -0.5226 | -0.2535  | -1.6568  | -1.4772  | -0.7343  | -0.3644  | -0.1128  | -0.4931  | 0.4951   | 0.4041   | -0.1039 | -0.09708 | -0.9964  |
| ANGEL2       | -0.5223 | -0.2784  | 0.4059   | 0.1854   | 0.4473   | -0.3483  | 0.3614   | 0.4031   | 0.2318   | 1.0998   | 0.2086  | 0.9696   | 0.2356   |
| CLN5         | -0.5223 | 0.6421   | 1.1554   | 0.9661   | 0.6559   | 1.0852   | 0.531    | 1.5835   | -0.09253 | 1.7129   | 1.1945  | 1.5757   | 2.9594   |
| ZFP91        | -0.5223 | 0.1869   | -1.1941  | -0.3965  | -0.5771  | -1.0675  | -0.589   | 0.31     | 0.5177   | -0.5097  | 0.361   | -0.5845  | -0.5434  |
| EHMT2        | -0.5221 | 0.1095   | 0.3382   | -0.2946  | 0.4847   | -1.0013  | -0.6913  | 1.1346   | -0.2315  | -0.00423 | 0.22    | 0.3699   | 1.0578   |
| TMPRSS3      | -0.522  | -0.53    | 0.08757  | -0.3599  | -0.7188  | 0.6119   | -1.2264  | -0.2226  | 0.4223   | 0.4578   | 0.2198  | 0.06451  | -0.166   |
| SLC30A7      | -0.5219 | -0.6022  | -0.3288  | 0.4254   | 0.4999   | -1.6403  | -0.1277  | 0.5895   | -0.2116  | -0.02472 | 0.06572 | 0.8737   | 0.9246   |

|               |         |          |          |          |          |          |          |          |          |          |          |          |          |
|---------------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| STON1-GTF2A1L | -0.5215 | 0.2639   | -0.3004  | -0.8479  | -0.1778  | -0.3931  | -0.1088  | 0.2234   | -0.00217 | 1.1548   | 0.42     | -0.3586  | -0.1713  |
| SLC1A1        | -0.5212 | 0.07549  | -0.03064 | -0.03046 | 0.001155 | 0.437    | -0.4279  | 0.2817   | -0.1079  | 0.4604   | 0.5876   | 0.2659   | 0.1574   |
| KLF14         | -0.5207 | -0.4388  | -0.2066  | 0.09495  | -0.8382  | -0.6414  | -0.4585  | -0.1706  | -0.1218  | -0.04295 | 0.3156   | -0.1442  | -0.4914  |
| CKS1B         | -0.5207 | -0.1919  | -0.01961 | -0.3701  | -0.4275  | -0.429   | -0.7142  | -0.5542  | -0.01339 | 1.7635   | 0.7623   | 0.1167   | -0.6573  |
| CDKN1B        | -0.5206 | 0.7962   | -0.1258  | -0.4216  | -0.1704  | 0.0997   | -0.4547  | 0.933    | -0.1993  | 0.7878   | -0.1698  | 0.4329   | 1.1987   |
| CD320         | -0.5204 | -1.108   | 0.6069   | 0.2513   | 0.245    | -0.2046  | -0.3761  | 0.4785   | 0.1803   | 0.4126   | 0.4886   | 0.1936   | 0.09424  |
| BLVRB         | -0.5202 | 0.2581   | 0.6175   | -0.1957  | 0.1106   | 0.05749  | 0.003283 | 1.4247   | -0.5154  | -0.09952 | 1.5166   | 1.1024   | 0.8983   |
| ZFPL1         | -0.5201 | 0.25     | 0.8381   | 0.1649   | 0.5173   | -0.3948  | 0.1383   | 0.4498   | 0.2485   | 0.8169   | 0.5394   | 0.5894   | 1.3144   |
| MCF2          | -0.5197 | -0.7571  | 0.7383   | -0.4398  | -0.1509  | -1.0772  | 0.3376   | -0.1954  | 0.8187   | -0.1931  | 0.5187   | 0.4507   | 0.7965   |
| FDXR          | -0.5193 | -0.3255  | -0.191   | -0.7237  | -0.1926  | 0.1414   | -0.743   | -0.1071  | 0.3567   | 0.6898   | 0.01345  | 0.7449   | -0.8307  |
| ZSCAN4        | -0.5188 | 0.00538  | -0.3129  | -0.2333  | -0.1626  | -0.7533  | -0.1545  | -0.1541  | 0.9958   | -0.2246  | 0.304    | -0.04877 | -0.1986  |
| ZNF671        | -0.5186 | 0.644    | 0.5903   | -0.9658  | -0.04281 | -1.5934  | -0.6862  | 0.7558   | 0.57     | -0.2164  | 0.3861   | 0.079    | 0.2408   |
| OR1E2         | -0.5186 | -0.5732  | -0.1049  | 0.2118   | -0.5841  | -1.3155  | -0.5108  | -0.5677  | 0.202    | 0.3319   | 0.2787   | -0.4666  | 0.2089   |
| CHPT1         | -0.5185 | -0.2822  | 0.3645   | -0.223   | -0.3622  | 0.4763   | -1.1502  | 0.4581   | 0.0964   | 0.9495   | -0.3699  | 0.5392   | 0.3538   |
| TRPV5         | -0.5184 | -0.1951  | 0.4922   | 0.03707  | -0.7873  | -0.242   | -0.4928  | -0.6667  | 1.0483   | 0.1608   | 1.2083   | 0.1142   | 0.4486   |
| TMC7          | -0.5183 | -0.05877 | -0.358   | -0.6337  | 0.1265   | -0.3221  | 0.1997   | 0.3022   | 1.0798   | 0.6545   | 0.04979  | -0.7042  | 0.444    |
| AHRR          | -0.5176 | -0.2219  | 0.6625   | 0.5168   | -0.01405 | 0.6      | 0.6551   | 0.5583   | -0.347   | 1.033    | 1.3574   | 1.5019   | 1.5695   |
| LRP6          | -0.5175 | 0.367    | -0.03146 | 0.1526   | 0.4265   | 0.4323   | 0.2709   | 1.2207   | -0.117   | 0.5801   | 0.4668   | 0.8581   | 0.552    |
| PHB           | -0.5173 | -0.4182  | -0.7181  | -0.8659  | -0.5577  | -2.2594  | -1.0712  | -0.4748  | 0.5776   | 0.7296   | -0.628   | -1.6433  | 0.4855   |
| DPCR1         | -0.5172 | -0.07356 | 0.566    | 0.4771   | -0.1086  | -1.5745  | -0.04839 | 0.5161   | 0.07202  | 0.5113   | 0.3134   | 0.9222   | 0.2123   |
| DHX16         | -0.5168 | -0.2056  | -1.4052  | -0.398   | 0.03236  | 0.1597   | -1.614   | -0.2328  | -0.3505  | 0.3232   | 0.09318  | -0.00274 | -0.1645  |
| GNB2          | -0.5164 | -0.06471 | -0.09746 | -0.2902  | -1.3633  | 1.0644   | -0.6516  | 0.8666   | 0.3705   | -0.6517  | 1.4604   | 0.7128   | 0.4754   |
| PLSCR2        | -0.5154 | -0.263   | -1.0756  | 0.5728   | 0.3702   | -0.8768  | -0.1579  | 0.6548   | -0.08906 | -0.02968 | 0.2112   | 0.28     | 0.4348   |
| PBX4          | -0.5154 | -0.462   | -0.8108  | 0.1578   | 0.08704  | -0.5353  | -0.4567  | 0.06541  | 0.5335   | -0.6161  | 0.257    | -0.2166  | 0.5047   |
| ATP2C1        | -0.515  | -0.582   | 0.3828   | 1.2675   | 0.1161   | 0.09491  | 0.1629   | 0.7943   | 0.6996   | 1.6424   | -0.3607  | 1.5294   | 1.2665   |
| GPR32         | -0.5149 | -0.6062  | -0.2908  | 0.6491   | 0.6808   | -0.00516 | 0.01409  | 0.753    | 0.1332   | 0.04315  | 0.9595   | 1.2929   | 0.362    |
| TCEB2         | -0.5148 | -0.339   | -0.5026  | -0.3801  | -0.3644  | -0.4707  | -0.3057  | -0.3705  | -0.2356  | 0.4541   | 0.413    | -0.8165  | -0.0716  |
| AGAP4         | -0.5141 | -0.3928  | -0.3705  | 0.4428   | 0.3072   | 0.3286   | -0.3482  | -0.3177  | 1.4258   | 0.5426   | 0.8085   | 0.04105  | 0.5795   |
| AGAP8         | -0.5141 | -0.3928  | -0.3705  | 0.4428   | 0.3072   | 0.3286   | -0.3482  | -0.3177  | 1.4258   | 0.5426   | 0.8085   | 0.04105  | 0.5795   |
| SOCS4         | -0.5139 | 0.2695   | 0.3725   | -0.08329 | -0.2177  | -0.05249 | -0.2463  | 0.9126   | -0.03118 | 0.1508   | 0.1115   | 0.243    | 0.501    |
| TMC5          | -0.5138 | -1.3868  | -0.2311  | 0.1935   | -0.7407  | -1.033   | -0.3863  | 0.325    | -0.622   | 0.2584   | -0.1022  | -0.4918  | 0.002835 |
| PTPRZ1        | -0.5133 | -0.2172  | -0.2722  | 0.4299   | -0.4122  | -1.2599  | -0.5558  | -0.01024 | 0.6447   | -0.4299  | -0.04822 | 0.4132   | -0.00114 |
| C14orf132     | -0.5132 | 0.1014   | -0.1658  | 0.4801   | 0.4637   | 0.7095   | 0.3832   | 1.3886   | -0.2851  | 1.1546   | 0.2567   | 1.1917   | 1.3559   |
| TDGF1         | -0.5131 | 0.00122  | -0.2208  | 0.03395  | -0.1132  | -0.03856 | 0.2568   | 0.6968   | 0.8195   | 0.7      | -0.1017  | -0.5484  | 0.5398   |
| CDK18         | -0.5124 | -0.7232  | 0.0348   | -0.6005  | 0.5695   | -0.6629  | -0.1041  | 1.0957   | -0.1738  | 0.02261  | -0.05752 | 0.3211   | 0.2742   |
| FCGBP         | -0.5113 | -0.2032  | 0.1422   | -0.2666  | -0.4136  | 0.04624  | -0.561   | 0.01362  | 0.1561   | 0.2887   | -0.2702  | -0.1341  | 0.1436   |
| LOC100133944  | -0.5113 | -0.2032  | 0.1422   | -0.2666  | -0.4136  | 0.04624  | -0.561   | 0.01362  | 0.1561   | 0.2887   | -0.2702  | -0.1341  | 0.1436   |
| LOC100290309  | -0.5113 | -0.2032  | 0.1422   | -0.2666  | -0.4136  | 0.04624  | -0.561   | 0.01362  | 0.1561   | 0.2887   | -0.2702  | -0.1341  | 0.1436   |
| UGT1A8        | -0.5109 | -0.5263  | -0.4624  | -1.0733  | 0.06293  | 0.7178   | 0.3062   | -0.2028  | 0.4304   | 0.5196   | 0.0399   | 0.6856   | 0.6183   |

|         |         |          |          |          |          |          |          |          |          |          |          |          |          |
|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| CHTF18  | -0.5103 | 0.3995   | 0.2458   | -1.1719  | -0.6679  | -0.5015  | 0.1736   | 0.04763  | 1.0916   | 0.5641   | 0.01634  | -0.3482  | 0.599    |
| RNF32   | -0.51   | 0.6726   | 0.01639  | 0.1659   | -0.4153  | 0.8717   | -0.4504  | 0.7294   | 0.68     | 0.5587   | 1.7915   | -0.2413  | 1.0407   |
| HMG2    | -0.5093 | 0.07428  | -0.00583 | -0.7248  | -1.4217  | -0.6835  | -0.429   | -0.2098  | 0.2216   | 0.3804   | -0.1171  | -0.7133  | 0.1134   |
| EFCAB6  | -0.5092 | 0.4323   | 0.317    | -0.623   | -0.1527  | -1.3254  | -0.505   | 1.0392   | -0.2539  | 0.6332   | 0.2369   | 0.1444   | -0.162   |
| SPINT2  | -0.5088 | 0.07988  | 0.5091   | 0.9087   | 0.06726  | 0.212    | -0.1804  | 1.4869   | -0.8333  | 0.5515   | 2.3997   | 1.8516   | 0.8047   |
| ZWILCH  | -0.5087 | 0.6298   | -0.1079  | 0.06976  | 0.204    | 0.6353   | -0.06495 | 1.3477   | 0.799    | 1.072    | 0.1527   | -0.00979 | 0.6162   |
| DLX3    | -0.5085 | -1.6054  | 0.915    | 0.001927 | 0.5483   | -1.6097  | -0.287   | 0.0967   | 0.3416   | 0.07159  | 0.2126   | 0.6418   | 1.4271   |
| FCRL2   | -0.5079 | -0.8422  | 0.2418   | 0.1898   | -0.3006  | 0.6662   | -0.4652  | -0.08357 | 0.4691   | 0.4048   | -0.02539 | 0.6347   | 1.1771   |
| HINFP   | -0.5073 | 0.05044  | 0.893    | -0.1854  | -0.06074 | -0.3354  | 0.6524   | 0.6647   | 0.2262   | 0.5419   | 1.4286   | 0.8365   | 0.1972   |
| SLCO2B1 | -0.5072 | -0.2106  | -0.5164  | -0.7419  | -0.5342  | 0.4337   | 0.01083  | -0.1975  | 0.3953   | 0.3472   | 0.4521   | -0.00446 | -0.2703  |
| HSD17B4 | -0.5072 | 0.4922   | 1.3523   | 0.2028   | -0.5301  | -0.146   | -0.8984  | 0.3247   | 0.4813   | 1.0692   | 0.3593   | 0.6957   | 0.8846   |
| CYP4X1  | -0.5067 | 0.2091   | -0.6518  | -0.1437  | 0.1473   | 0.152    | 0.1546   | 0.4919   | 0.2833   | -0.399   | 0.6351   | 0.6519   | 0.4031   |
| GPR180  | -0.5061 | 0.2382   | 0.1699   | -0.1555  | 0.2605   | -0.07927 | -0.00818 | -0.1615  | 0.02202  | -0.04616 | 1.2299   | 1.0842   | 0.6855   |
| GGA2    | -0.5055 | -0.4214  | 0.2195   | 0.4873   | -0.1598  | 0.8886   | -0.2008  | 0.8452   | 0.08079  | 0.9076   | -0.3624  | 2.0141   | 1.4592   |
| ROPN1   | -0.5054 | 0.599    | 1.4661   | -1.2406  | 0.2555   | -0.05564 | -0.03811 | 1.5098   | -0.2691  | 1.3305   | 0.4865   | 1.6795   | 1.1917   |
| RNF2    | -0.5051 | 0.2047   | -0.2062  | -0.3407  | 0.3763   | -0.4571  | -0.3874  | 0.1018   | -0.05651 | 0.1493   | 0.2373   | -0.05373 | 0.3006   |
| PRDM13  | -0.5048 | -0.05576 | 0.4954   | 1.1659   | 0.6226   | 0.7122   | 0.9089   | 1.8696   | -0.2528  | 1.9789   | 0.4223   | 1.9631   | 2.2205   |
| NEK9    | -0.5047 | -0.7272  | -0.2527  | -0.5617  | -0.44    | -0.4798  | -0.1655  | -1.0089  | 0.2103   | 0.5708   | -0.2089  | 0.1434   | -0.09123 |
| SLC6A18 | -0.5035 | 0.5192   | 1.1108   | 1.3361   | 0.1618   | 2.6075   | 0.7677   | 2.0234   | 0.5958   | 2.3252   | 1.7632   | 2.9943   | 1.7735   |
| SLC5A7  | -0.5032 | 0.126    | -0.07253 | -0.1859  | 0.1625   | -0.9483  | 0.7874   | 0.846    | 1.3824   | 0.05014  | 0.591    | 0.5339   | -0.1564  |
| ZNF813  | -0.5023 | -0.1201  | 0.08307  | -0.2295  | 0.05713  | -1.4293  | -0.1052  | 0.06897  | 0.6871   | -0.1755  | 0.7689   | -0.259   | 0.1828   |
| KDELR2  | -0.502  | -1.2448  | -0.5547  | -0.3239  | 0.535    | 0.165    | 0.3005   | 0.5234   | -0.2405  | 0.5784   | 1.1142   | -0.0411  | 0.3719   |
| KRT79   | -0.5018 | -0.09625 | -0.2196  | -0.821   | 0.01874  | -0.5337  | -0.1138  | 0.7254   | 0.6917   | -0.2967  | 0.06672  | -0.1573  | -0.3682  |
| AP3S1   | -0.5018 | -0.2819  | 0.7022   | 0.1569   | 0.2318   | -1.0918  | -0.9245  | 0.05788  | 0.4056   | 1.3321   | -0.3886  | 1.383    | 0.2529   |
| KCNH3   | -0.5012 | -0.761   | 0.3262   | -0.6369  | -0.05894 | -0.624   | -1.1603  | -0.5693  | 0.5342   | 0.009643 | -0.3318  | 0.05279  | 0.1456   |
| RNF114  | -0.501  | 0.2592   | -0.00373 | -0.4066  | -0.1579  | -0.9753  | 0.4239   | 0.5529   | 0.5901   | -0.06397 | 0.4291   | 0.08089  | -0.03706 |
| SRY     | -0.501  | -0.3105  | 0.1268   | 0.5828   | 0.4403   | 0.08408  | 0.6278   | 1.094    | 0.1942   | 1.0489   | 0.5711   | 0.06093  | 1.0627   |
| CPT1B   | -0.5005 | -0.3086  | 0.6805   | -0.7164  | -0.01222 | -0.3859  | -0.4021  | 0.1851   | 0.4867   | 1.3142   | -0.2016  | 0.9407   | -0.4216  |
| ADPRH   | -0.5004 | -0.5059  | 0.8041   | 0.1145   | -0.07427 | -0.1986  | -0.2905  | 0.2954   | 0.1464   | 0.07763  | 0.6977   | 0.3623   | 0.29     |

**Table 4: Overlapping of Two Lists of Candidate Metastatic Essential Gene**

**Gene Name**

LDHC  
PDP1  
JUB  
MAP3K7  
CUL2  
ACTG2  
AGTR1  
MAT1A  
OSCAR  
PHTF2  
MED27  
LUC7L2  
ADAM7  
PTPRJ  
CLCA4  
PIK3CB  
ZNF645  
CDHR5  
GEM  
ZNF37A  
MAPK1  
SIRPG  
GLUL  
HLA-DPA1  
EIF2AK3  
FAM108B1  
ZNF611  
NHP2L1  
ZNF76  
FLG2  
TRPT1  
ZNF514  
SORCS3  
PVRL4  
IL17A  
MUSK  
LOC100287382  
PROCR  
ZNF222  
HLA-DRB5  
SLC28A2  
LOC100290936  
TGFB1  
ZSCAN4

ZNF585A  
ZNF524  
KCNK2  
ZNF585B  
ZNF628  
RGS1  
TNK1  
CDC42BPB  
TAF1B  
ENOX2  
FGF9  
UBE2G2  
SPI1  
NBEA  
ZNF347  
DDI2  
ST6GALNAC6  
RDH8  
SERPINA4  
MC5R  
CEACAM6  
SERPINA1  
BHLHE41  
AMY2A  
SIK3  
TAF1L  
STS  
CES1P1  
STX3  
LYN  
PAPD5  
OSTM1  
MXD4  
INHBA  
PFDN1  
NAALAD2  
TDGF1P3  
USP21  
GUCY1B2  
OR6V1  
NUP107  
PRSS42  
KCNH2  
THOC3  
THEM5  
ZNF484  
SFTPA1

ZNF780B  
ZNF653  
PCSK1  
MTMR1  
BUB1  
HAAO  
FBXW11  
HSD17B7  
SIM2  
ZFP91-CNTF  
HIST1H2BB  
CAPN5  
MAT2A  
ZNF667  
STRADA  
PPP1R10  
CAPN1  
PKNOX2  
RAB4B-EGLN2  
CNTF  
PHF13  
SPINLW1  
NLRP12  
YKT6  
RALY  
ILKAP  
CNOT8  
ZAK  
ATP6AP2  
LOC100507804  
GRIK4  
DLK1  
MTHFD1L  
AGAP7  
ANK3  
PSIP1  
LONRF3  
CIB3  
IRS2  
STMN3  
FAM18A  
RBL1  
MYO3B  
SIX4  
IL22  
RFK  
TNFAIP8

REM2  
BMP2K  
NFE2L2  
ZNF438  
BBS4  
COBL  
ELAC1  
ARFGAP3  
ADORA2B  
BBS7  
KCNA2  
GLUD1  
MEIS3  
DOCK2  
DPCR1  
PPIL3  
PCDHA13  
HELLS  
SSX1  
ADAM28  
EFEMP1  
ACMSD  
APEH  
TNFSF10  
HDAC3  
HDAC2  
S100B  
GPR39  
PRKAR1A  
DDX59  
ADRA1A  
HNRNPH1  
DNAJB6  
PC  
SLC5A12  
HSFY1  
HSFY2  
SKIV2L2  
DEK  
PRMT1  
WISP1  
OR2T10  
PRMT8  
LOC100508181  
LOXL4  
TIE1  
DLG2



CCRL1  
SEC23A  
TRPM5  
ACRBP  
ACADS  
METTL4  
PKN1  
SPACA5B  
SLC7A11  
NCOA5  
PKM2  
SLC41A1  
GPR15  
PHLPP1  
NDN  
RDX  
TRAIP  
ATP5G3  
COL9A1  
CDH7  
DCX  
RNF121  
SELPLG  
NFATC1  
COL4A2  
RNASE4  
RCAN1  
UBE2Q1  
NCSTN  
LEP  
SLC35C2  
RASL11B  
INVS  
WDSUB1  
LOC646096  
LOC729468  
HEYL  
MEP1B  
JAK1  
ALKBH3  
CYP3A4  
RAB3GAP2  
CDX1  
S100A8  
BBX  
OR1E2  
OR1E1

IARS2  
BBOX1  
HS2ST1  
S1PR2  
APOB  
RAVER1  
NT5C2  
HRSP12  
RARA  
WWOX  
TBC1D9B  
POLL  
MATN3  
UBR2  
DCTN4  
PGM2  
WFDC12  
PRDM7  
PRDM9  
KRT16  
PRDM2  
HAS2  
ALDOA  
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SFXN2  
HNRNPA3  
LOC652797  
TAL1  
GYS1  
IDH2  
FBXO6  
NKX2-1  
LENG1  
LHX8  
TRAM1  
SMAD9  
RARS2  
LGALS3  
TP53BP1  
PTPN13  
PMF1  
DDX5  
S100A14  
GNAT2  
LAMA2  
RNF8  
CD55

ATP13A1  
SEMA6C  
C12orf52  
DLX6  
PON1  
QPRT  
ALG10  
BCO2  
BMP6  
ZBTB32  
PZP  
ZBTB39  
N6AMT1  
LOC728554  
ETAA1  
TGFA  
MKX  
ZBTB22  
SPACA5  
CTBP2  
RXFP1  
SLC25A4  
CCKBR  
GZMB  
GPR179  
ZCCHC14  
DNAJC27  
MED7  
SLC27A2  
LOC440563  
POLR2H  
CLK2P  
ZFP112  
ZFP36L1  
BCL2  
ZNF286A  
ETV1  
CC2D1A  
THBS2  
BCL9  
RBM26  
BCAS2  
A4GALT  
FZD3  
SOD1  
FCGR2C  
GRIA1

CLEC3A  
NINL  
ABCC3  
CALM3  
CHN2  
BIK  
FCGR2A  
OPN4  
OBP2A  
FGF10  
GATA1  
TRIM48  
ZNF182  
TRIM43  
HNRNPA3P1  
ROBO1  
MS4A1  
SLC4A2  
SLC4A1  
ROBO3  
GLP2R  
SPRED1  
CUTC  
SCUBE3  
FXVD6-FXVD2  
ZNF813  
SOCS5  
NR0B2  
CDKL3  
LOC649330  
ISCU  
C5orf32  
TIAL1  
SNRPA  
SNRPF  
LMBR1  
SLC38A2  
10-Mar  
SSH3  
LOC100507699  
SP110  
ATP6V1B2  
TRIM43B  
RBX1  
GMIP  
GALC  
EFCAB1

RNF11  
SFTPC  
GNMT  
CTRL  
PRSS55  
RFX5  
KCTD3  
ITGA3  
AK4  
SUGT1  
TET1  
WIF1  
Luciferase  
OR6K6  
RSC1A1  
ZNF85  
METAP1  
PRKAG1  
SGPP2  
IL21R  
SLA  
FOS  
CD96  
RMND5A  
ACOT11  
MKKS  
CNTNAP1  
CALCRL  
NACAP1  
KHDRBS2  
MPP1  
LEPREL2  
CHST2  
OSGEPL1  
LMBRD1  
FSHR  
ARHGAP23  
SACM1L  
ACVR2B  
HIPK1  
MATR3  
CAMK1D  
AOC3  
SMARCAD1  
ADPGK  
SPOCK1  
PLBD2

GLRX2  
UGT1A7  
NPAS1  
TNRC6C  
UGT1A3  
TMEM33  
MAP3K1  
SCG3  
UCK1  
PIK3R6  
LACTB  
CRSP8P  
GIMAP4  
CPPED1  
FETUB  
DIS3  
TSLP  
SLC17A4  
SLC6A8  
POFUT2  
CYP4F3  
TSSK3  
CSN3

**Table 5: Go Enrichment of Candidate Metastasis Genes**

| Gene Set Name [# Genes (K)]                                      | Description   | # Genes in Overlap (k) | p value              |
|--|---|------------------------|----------------------|
| ACTIVATION_OF_MAPK_ACTIVITY [40]                                 | Genes annotated by the GO term<br>GO:0000187. The initiation of the activity of<br>the inactive enzyme MAP kinase by<br>phosphorylation by a MAPKK.                         | 6                      | 1.21 e <sup>-2</sup> |
| HOMEOSTASIS_OF_NUMBER_OF_CELLS [20]                              | Genes annotated by the GO term<br>GO:0048872. The biological processes<br>involved in the maintenance of the<br>equilibrium of cell number within a<br>population of cells. | 4                      | 1.45 e <sup>-2</sup> |
| POSITIVE_REGULATION_OF_MAP_KINASE_ACTIVITY [46]                  | Genes annotated by the GO term<br>GO:0043406. Any process that activates or<br>increases the frequency, rate or extent of<br>MAP kinase activity.                           | 6                      | 2.32 e <sup>-2</sup> |
| RECEPTOR_SIGNALING_PROTEIN_SERINE_THREONINE_KINASE_ACTIVITY [34] | Genes annotated by the GO term<br>GO:0004702.   | 5                      | 2.32 e <sup>-2</sup> |